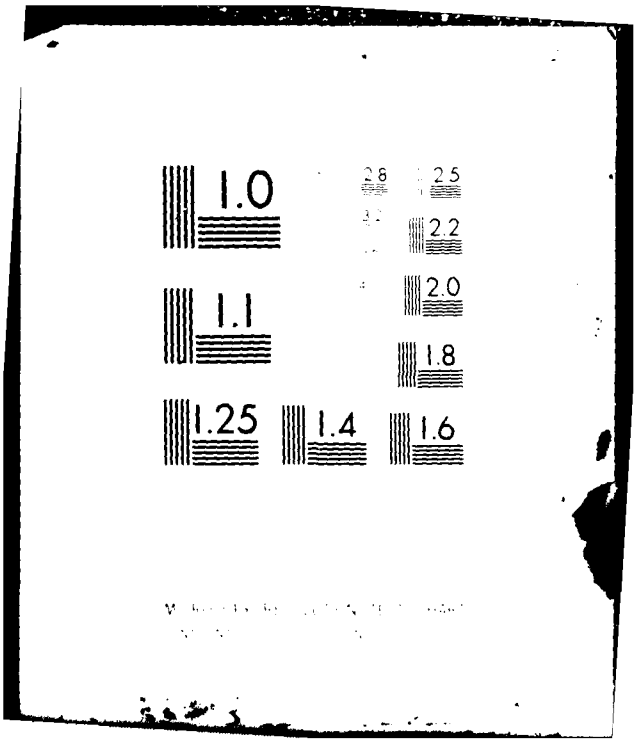
AD-A112 859 WASHINGTON STATE DEPT OF GAME ABERDEEN F/G 13/2
GRAYS HARBOR AND CHEHALIS RIVER IMPROVEMENTS TO NAVIGATION ENVI--ETC(U)
JAN 82 S A KALINOWSKI, R C MARTIN, L D COOPER DACW67-80-C-0091
UNCLASSIFIED NL

1 OF 3
AD A
112859


1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

(1)

GRAYS HARBOR AND CHEHALIS RIVER IMPROVEMENTS TO NAVIGATION ENVIRONMENTAL STUDIES

WILDLIFE STUDIES AT PROPOSED DISPOSAL SITES IN GRAYS HARBOR, WASHINGTON

PREPARED BY:

WASHINGTON DEPARTMENT OF GAME

US Army Corps of Engineers
Seattle District

JANUARY 1982

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A122 159	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Wildlife studies AT proposed disposal sites in Grays Harbor, Washington	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Stephan A. Kalinowski, Robert C. Martin, Larry D. Cooper	8. CONTRACT OR GRANT NUMBER(s) DACW67-80-C-0091
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Department of Game, Aberdeen, WA 98520	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Seattle District, U. S. Army Corps of Engineers, P. O. Box C-3755, Seattle, WA 98124	12. REPORT DATE January 1982
	13. NUMBER OF PAGES 202
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

GRAYS HARBOR	SHOREBIRDS	MAMMALS
WASHINGTON (STATE)	BIRDS	
WILDLIFE	DREDGING	
INVENTORY	ENVIRONMENTAL IMPACT	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A 15-month study to inventory wildlife resources on 4 proposed terrestrial dredged material disposal sites and 1 intertidal disposal site was initiated in April, 1980. Major emphasis was placed on inventorying birds and mammals to assess the value of these areas to wildlife. Amphibians, reptiles and plants received less emphasis.

Seven species of amphibians and 3 species of reptiles were captured on fill site 16, 17, and 18 during this study. The spotted frog and Dunn's salamander

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

have been reported only rarely in Grays Harbor County. Most individuals of these two groups of animals would be killed by disposal of dredge materials on these sties.

At least 46 species of waterbirds use the main channel and sloughs proximal to the Cosmopolis Reach of the Chehalis River. Mallards and scaup were the most common waterfowl; highest numbers were seen during winter. Areas preferred by waterfowl were river marshes and upper reaches of sloughs. Large numbers (>200) of western grebes, gulls and diving waterfowl used the Cosmopolis Reach during all seasons.

During dredging, direct impacts to waterfowl and bald eagles would be negligible; most observations were 5 kms or more upstream from proposed dredging activity. Impacts (i.e. decreased hunting success due to suspended particulates) to diving birds would be minimized by dredging between August and October, when numbers of birds are lowest. Dredging during ebb tides would result in sediments disturbed by dredging flowing into the harbor.

COVER PHOTOGRAPH: Establishing a scent station for wildlife censusing.

WASHINGTON STATE
DEPARTMENT OF GAME
ABERDEEN, WA
98520

WILDLIFE STUDIES AT PROPOSED DISPOSAL SITES IN GRAYS HARBOR, WASHINGTON

by

Stephan A. Kalinowski
Robert C. Martin
Larry D. Cooper

Work performed for the Seattle District U.S. Army Corps of Engineers under Contract Number DACW67-[illegible]-C-0091.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

Many individuals of many organizations donated their time, advise or information to our team in preparing this report. We would like to thank the personnel of the USFWS Olympia office especially Jeff Opdycke and Ron Starkey, Drs. John Armstrong and Ron Thom and the rest of the staff of the USACOE Environmental section for their critical review of the manuscript. The Port of Grays Harbor and Grays Harbor Planning Commission for their assistance in locating information in a timely manner. Jean Martin for preparing some of the final figures in their report. Jack Howerton, Jack Smith, and staff of the Aberdeen office, Washington State Department of Game for the opportunity to work among true professionals.

PROJECT PERSONNEL

Jack Howerton was the principal investigator. He initiated the study and provided field assistance, administrative and technical support and supervision throughout its duration.

Stephan A. Kalinowski was the project leader. He directed the research, supervised project biologists and assistants, and conducted the portions of the study involving big game, amphibians, reptiles, human use, and vegetation.

Specific contributions of each project biologist are identified below by individual portion of the overall study. Results of each biologist's efforts, in edited form, are presented in this report.

Avian Species

Robert C. Martin was primarily responsible for all work involving birds.

Aquatic Furbearers and Small Mammals

Larry C. Cooper had primary responsibility for all work involving aquatic furbearers and small mammals.

Gene McKeen assisted project biologist and the project leader with various portions of the study.

ADMINISTRATIVE SUMMARY

Objectives:

1. Determine species composition and relative abundance of wildlife in major habitats on proposed disposal sites.
2. Determine human use of wildlife in proposed disposal areas.
3. Estimate economic impact of project on wildlife.
4. Identify wildlife habitat compensation sites and recommend plan to mitigate impacts on wildlife.
5. Identify food organisms of waterfowl and shore birds utilizing the south shore of Grays Harbor.

Findings:

1. Thirty-one species of mammals, 96 species of birds, 6 species of amphibians, and 3 species of reptiles were found to utilize, to some extent, proposed disposal sites 16, 17, and 18 near Junction City, Washington.

   An average year round density of 20 passerine bird/ha was observed on the Junction City sites. Marsh within the proposed disposal sites received 800 waterfowl use days per month during winter. Marshes and shrub swamp habitats support high populations of both beaver (66 individuals/km^2) and muskrat (425 individuals/km^2). Populations of deer mice were highly

variable with a low of 35 individuals/ha in shrub swamp habitat during spring to a high of 400 individuals/ha during winter in that same habitat.

2. Four trappers took $1316.65 worth of furs from wetlands on proposed disposal site 17 or approximately $70.00/day of trapping. Hunters, usually teenagers, were interviewed on the Junction City and marsh establishment sites. Although we have no estimate of the number of man-days spent hunting on these areas, we believe that both areas, but especially the marsh establishment site, receive considerable use. Primarily because both areas are within walking distance of populated areas. Also several bird watchers and hikers were seen on these sites.
3. Because of our lack of data and our inability to estimate impacts on non-consumptive users of wildlife we have not estimated the economic impact to wildlife.
4. Five areas where possible habitat compensation sites are located have been identified in this report. Three areas located on the Chehalis River, 1 on the Elk River and 1 on the Humptulips River. Advantages and disadvantages of each have been identified and listed in the conclusions and recommendations section.

5. Invertebrates were found to be the most important group of organisms in the diet of both waterfowl and shorebirds. Corophium spp. and Eogammarus confervicolus figured most prominately in the diets of both shorebirds and waterfowl.

ABSTRACT

A 15-month study to inventory wildlife resources on 4 proposed terrestrial dredged material disposal sites and 1 intertidal disposal site was initiated in April, 1980. Major emphasis was placed on inventorying birds and mammals to assess the value of these areas to wildlife. Amphibians, reptiles and plants received less emphasis.

Seven species of amphibians and 3 species of reptiles were captured on fill sites 16, 17, and 18 during this study. The spotted frog and Dunn's salamander have been reported only rarely in Grays Harbor County. Most individuals of these two groups of animals would be killed by disposal of dredge materials on these sites.

At least 46 species of waterbirds use the main channel and sloughs proximal to the Cosmopolis Reach of the Chehalis River. Mallards and scaup were the most common waterfowl; highest numbers were seen during winter. Areas preferred by waterfowl were river marshes and upper reaches of sloughs. Large numbers (>200) of western grebes, gulls and diving waterfowl used the Cosmopolis Reach during all seasons.

During dredging, direct impacts to waterfowl and bald eagles would be negligible; most observations were 5 kms or more upstream from proposed dredging activity. Impacts (i.e. decreased hunting success due to suspended particulates) to diving birds would be

minimized by dredging between August and October, when numbers of birds are lowest. Dredging during ebb tides would result in sediments disturbed by dredging flowing into the harbor.

Disposal on wetland sites would destroy critical habitat for many birds. A high diversity of songbirds (49 species) and high population densities were observed all year. In the wetland disposal area (sites 16, 17, 18), average year-round density was 20 songbirds per ha (range 14-33). Eighteen species of waterfowl, herons, grebes, cormorants, rails, shorebirds and kingfishers used sloughs and marshes on proposed disposal sites. Peak waterfowl use occurred in marshes during winter with 80 waterfowl days per ha per month.(Nov.-Mar.). High densities of screech owls and pygmy owls were observed in forested swamps. Ruffed grouse use of forested swamps was also high (2.1 ha per grouse).

Impacts to birds nesting on sites 16, 17, and 18 would be minimized by filling between September and February, when most birds are not nesting.

It has been proposed to establish an 8-20 ha salt marsh west of Newskah Creek on Grays Harbor, using maintenance dredged material. The salt marsh establishment site and a control site, both located on the south shore inner harbor, were studied to determine bird use. Low use of the south shore inner harbor by shorebirds and waterfowl, relative to the rest of Grays Harbor, was observed during aerial censuses. Much lower use of the salt

marsh establishment site, compared to the control site, was observed.

Shorebirds used the area only during migrations. Seventy-eight percent of all observations were made during spring migration. Feeding and migratory routes in the inner harbor were over the mid-channel flats and into Bowerman basin. Western sandpipers, dunlin and dowitchers comprised 99.4% of all observations.

Pintails and mallards were the most common dabbling ducks in Grays Harbor with peak use occurring during fall migration. Canvasbacks were the most common diving duck, most were seen during winter months. Bald eagles were regularly seen during winter at the salt marsh establishment sites. Peregrine falcons were observed at both marsh establishment and marsh control sites.

Overall impact of changing 8-20 ha of tideflat into salt marsh should be positive for birds. Salt marshes are used as roosting and feeding areas by shorebirds and waterfowl, especially during high tides.

Food habits of shorebirds and waterfowl were studied to determine important food items. Dunlin fed primarily on amphipods. Corophium spp. comprised 40% of their diets. Eogammarus confervicolus represented 5% of their food items. Tanaids comprised 31% of food items consumed. Western sandpipers and sanderlings fed mostly on oligochaetes and seeds of salt marsh plants. Western sandpipers also fed on E. confervicolus and Corophium spp.

Pintails and mallards fed primarily on intertidal invertebrates. Amphipods comprised 63% of pintail's diets (Corophium spp. 59%, E. confervicolus 3%). Seeds of salt marsh plants comprised 30% of their diets. Mallards were found feeding on amphipods (93%). E. confervicolus (88%) and Corophium spp. (5%) were their most important prey. Seeds of salt marsh plants (5%) also supplemented their diets.

Seventeen species of small mammals, 9 species of furbearers and 2 species of big game were found on the study area. The majority of site 16 and 17 are prime beaver (66 individuals/km^2) and muskrat (425 individuals/km^2) producing areas. In addition river otter were commonly seen in the sloughs and river adjacent to and within proposed fill boundaries. Deposition of dredge material will probably eliminate most individuals of these species regardless of time of deposition. The more mobile furbearers and big game will be able to move into adjacent areas. Survival of these individuals would be questionable and dependent upon the availability of space in populations in surrounding areas.

Five possible mitigation sites have been identified; 3 in the Chehalis system, 1 in the Elk river system, and 1 in the Humptulips river system. The 3 sites located in Township .17N. Range.8W. are located in the Chehalis river system. Because of their location they are the most desirable of the 5 areas. In kind, habitat replacement, for habitat destroyed on disposal sites, could be accomplished on each of these sites.

PART I

INTRODUCTION

STUDY AREA

INTRODUCTION

Grays Harbor is the third largest estuary in the Pacific Northwest (Proctor et al. 1980). The estuary is approximately 29 km long and 21 km wide at its widest point and is located 145 km southwest of Seattle (Gatto 1978)(Fig. 1). Sixteen percent (15.33 km^2) of the area between mean lower low water (MLLW) and extreme high water (EHW) is undiked salt marsh; 6.88 km^2 has been altered for agricultural use (Gatto 1978). Also 1.02 km^2 of freshwater marsh and 3.85 km^2 of wooded swamp are contiguous with Grays Harbor (Gatto 1978). Much of these wetlands plus the flood plain of the Chehalis River upstream to Montesano is identified as critical habitat for wildlife (ACOE 1975).

The Port of Grays Harbor has proposed utilizing approximately 360 hectares of these wetlands east of Junction City, Washington, for disposal of dredged material which will be generated by the proposed widening and deepening of the Grays Harbor navigation channel (Fig. 1b). The initial dredging will generate 2.75 million m^3 east of the 101 highway bridge which would be deposited in these areas. As much as 55,000 m^3 of maintenance dredged material would be placed on these sites yearly.

The objectives of this study were to:

1. determine species composition and relative abundance of wildlife in major habitats on proposed disposal sites.
2. determine human use of wildlife in proposed disposal areas.

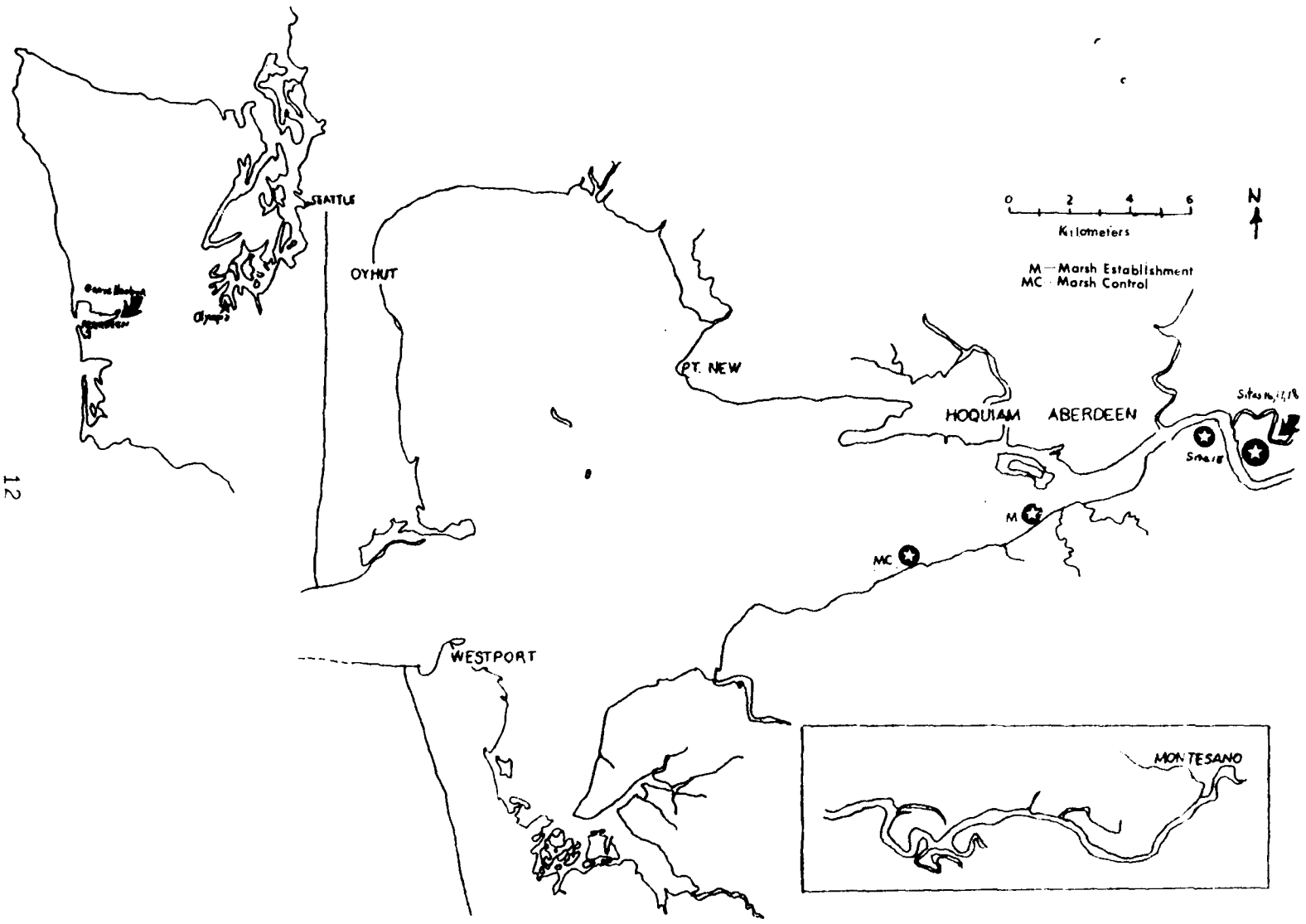


Figure 1. Primary study site locations around Grays Harbor, Washington, 1990-91

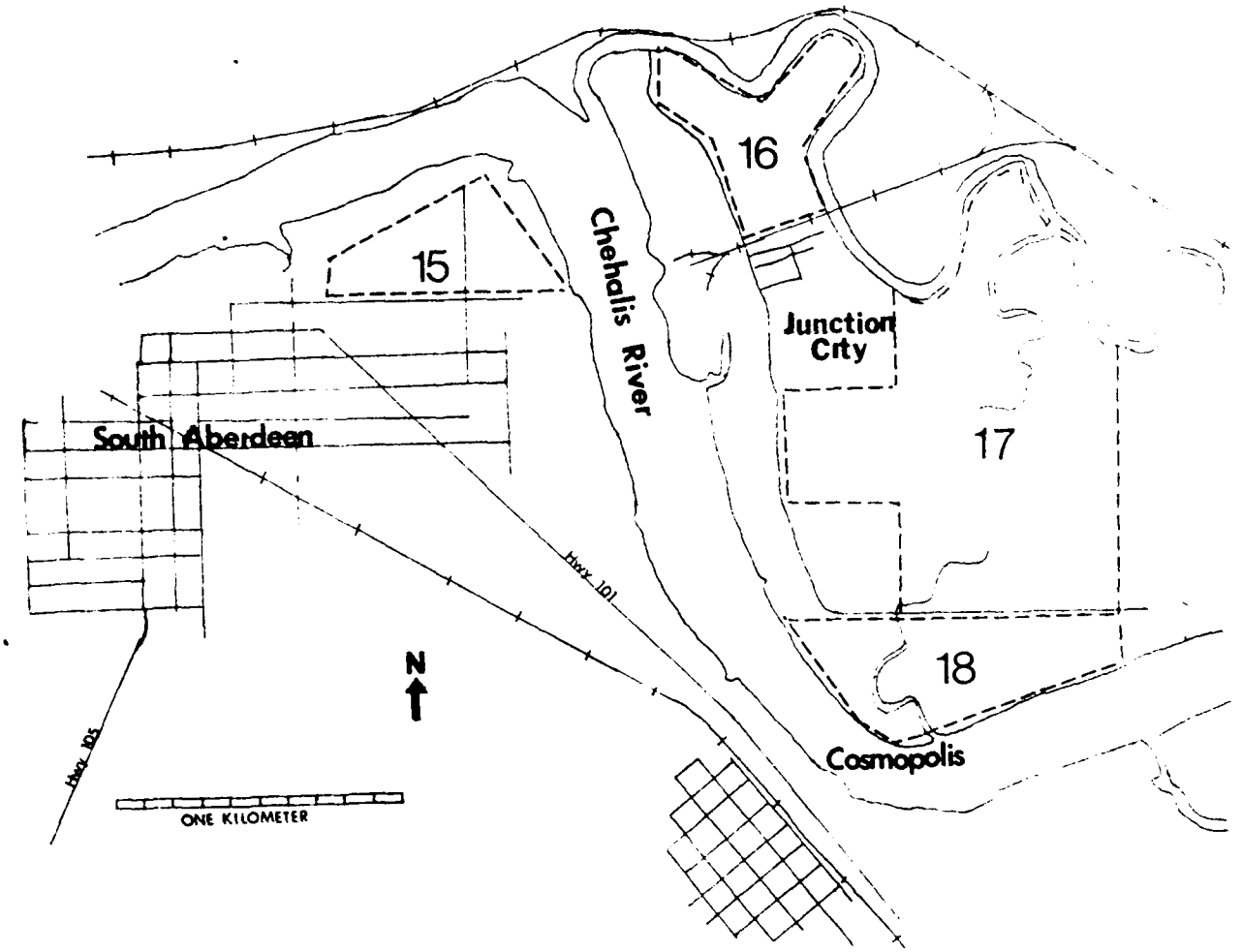


Figure 1b. Location of proposed dredged material disposal sites 15, 16, 17, and 18, Grays Harbor, Washington.

3. estimate economic impact of project on wildlife.
4. identify wildlife habitat compensation sites and recommend plan to mitigate impacts on wildlife.
5. identify food organisms of waterfowl and shore birds utilizing the south shore of Grays Harbor.

It has also been proposed that an 8-20 ha salt marsh be constructed west of Newskah Creek with maintenance dredged material (Fig. 1). This study included objectives to establish baseline information on bird use of the salt marsh establishment area, and determine food items important to waterfowl and shorebirds using the area.

STUDY AREA

Two distinct study areas were evaluated for impacts of disposal of material from Grays Harbor widening and deepening project. The "upland" disposal sites 15, 16, 17 and 18 formed one study area; and the proposed marsh establishment site west of Newskah Creek was the other study area (Fig. 1). Ten study sites were located on fill sites 16, 17, and 18 (Fig. 2).

Site 15 (23.3 ha) is owned by Weyerhaeuser Company. The property is used for sorting and storing logs and chips for export and domestic use. There is also some light residential use located in this area. After our initial field survey of this site in May 1980, we decided not to sample this area for wildlife use because of the poor quality of habitat present in this area.

Site 16 (23.2 ha) was relatively undisturbed except for the Redimix Cement Company which occupied 1.9 ha on the west side.

Site 17 (92.2 ha) was logged around 1969, when approximately 300,000 board feet of Sitka Spruce were harvested. Also, 13 ha are used by Roderick Timber Company for log storage and dredge spoils storage. The site is now undisturbed except for the area used by Roderick Timber Company.

Site 18 (31.7 ha) is relatively undisturbed, although dredge spoils have been placed on approximately 3 ha sometime in the past. This site is the driest of all three proposed fill sites.

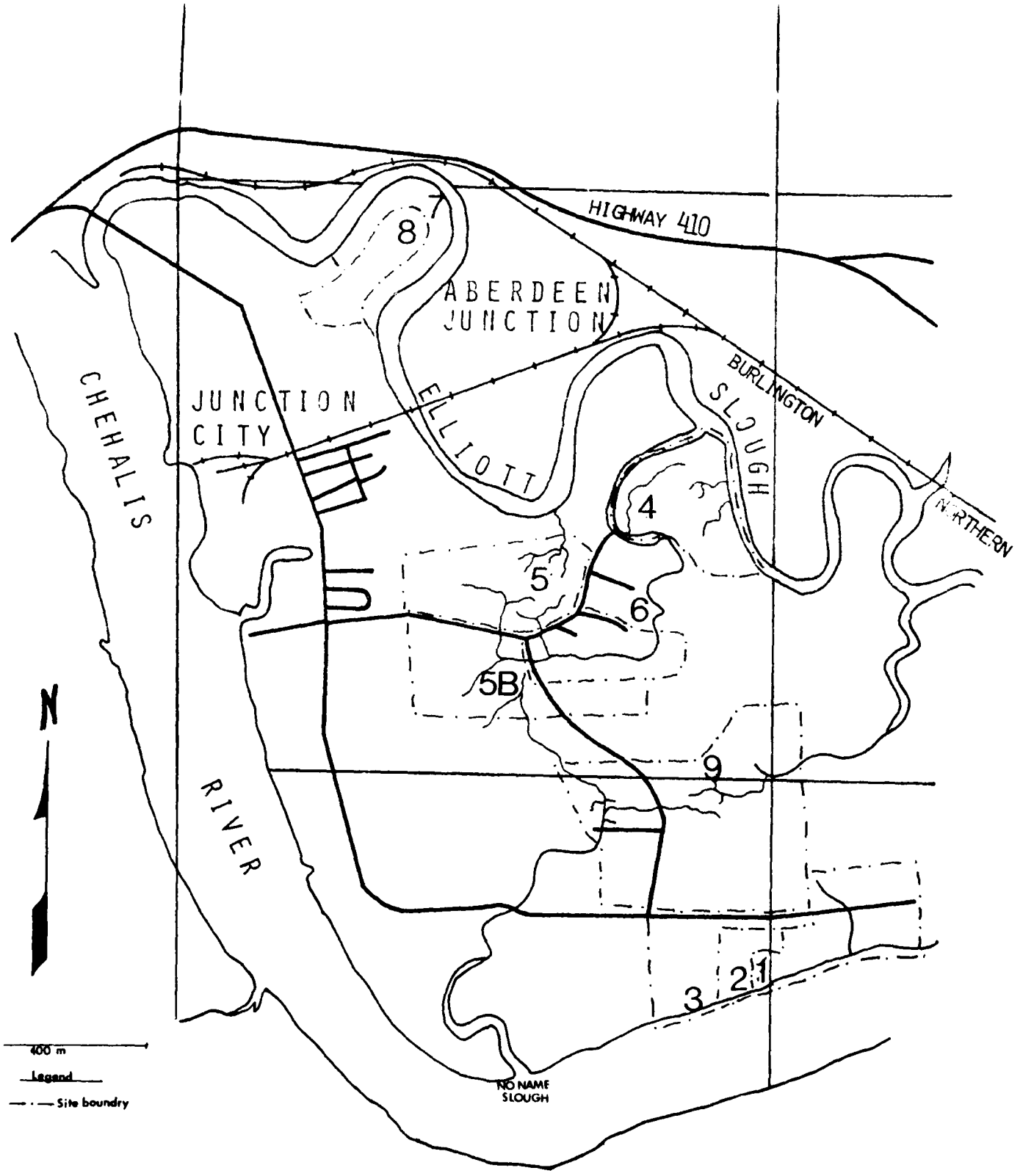


Figure 2. Location of study sites associated with proposed disposal sites 1, 17 and 18 near Junction City, Washington.

Geography of Junction City Sites

The Junction City sites occupy a portion of the terminal part of the Chehalis River valley. The Chehalis River valley exhibits river meanders characteristic of a "mature" river (Eddy 1966). Soils are unconsolidated silt, sand, and gravel deposited by the Chehalis River during floods (Eddy 1966). Over 95% of the area of sites 16, 17, 18 are subject to flooding during a 100-year flood (Fig. 3). More than 50% of the area is subject to flooding during winter months and more than 20% of the area is subject to normal tidal action (Fig. 4). Average rainfall is 216 centimeters; 70% of the rain falls between October-March of each year (Proctor et al. 1980).

Soils are mostly hydritic and support many plants associated with wetlands. This area lies in the transition zone between the Sitka Spruce and western hemlock regions (Proctor et al. 1980). The majority of trees logged off this area have been Sitka Spruce (Fred Abramson, per. comm.[1]).

Geography of Marsh Establishment and Control Sites

The marsh establishment and control sites are both intertidal mudflats located on the south shore inner Grays Harbor.

---

[1] Address: Roderick Timber Company, Junction City, WA.

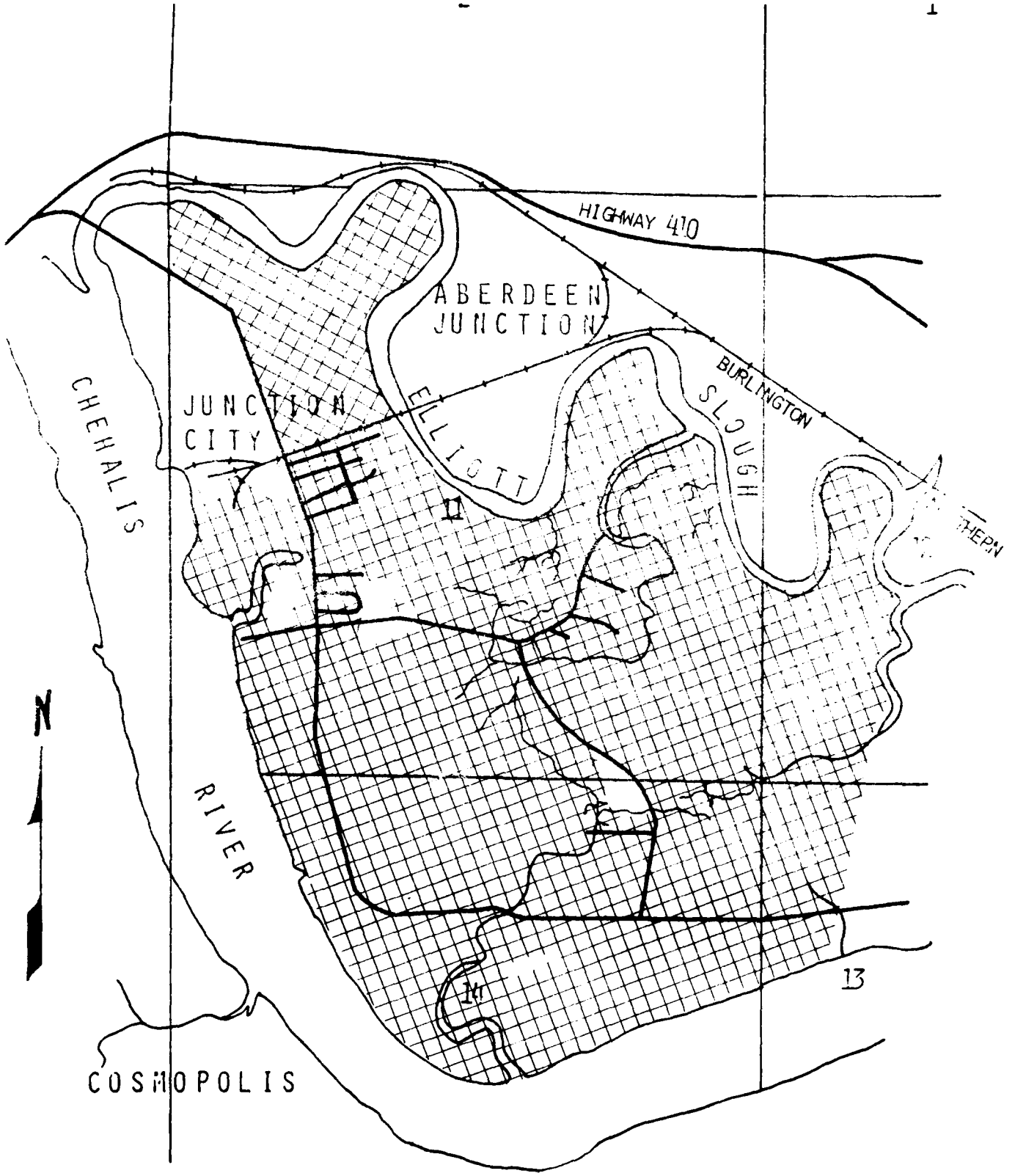


Figure 3. Area around Junction City, Washington which would be inundated by 100-year flood (ACOE 1971).

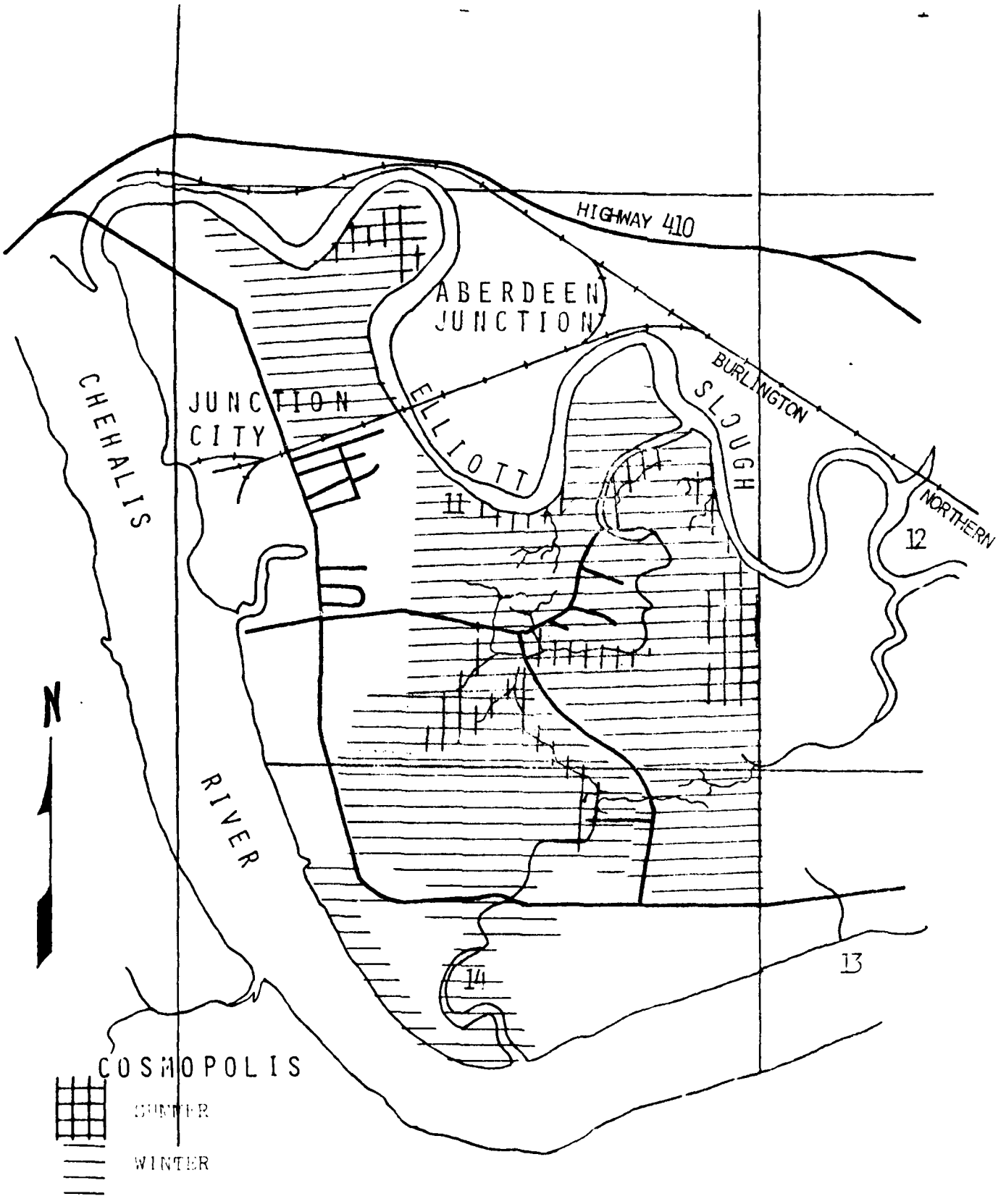


Figure 4. Areas around Junction City, Washington, subject to tidal action during summer and winter.

Both sites are bordered by immature high marsh (Smith, Mudd and Messmer 1976). The marsh at the establishment site is not extensive, being limited to the western edge of the site (Fig. 5).

The flats themselves extend from M.L.L.W. to +2.4 M. at both the establishment and control sites. Sediment at the establishment site is predominately mud, silt and fine sand (< 4-500μ)(Phipps et al. 1976). The control site is silt and fine sand (4-500μ)(Phipps et al. 1976). Both areas have beds of eelgrass, Zostera noltii predominates but Z. marina is also present. These beds may be of recent origin as they were not reported by Smith et al. (1976). Both areas have been used for log storage in the past (Steve Lancaster, per. comm.[1]).

---

[1] Grays Harbor Regional Planning Commission, Aberdeen, WA 98520.

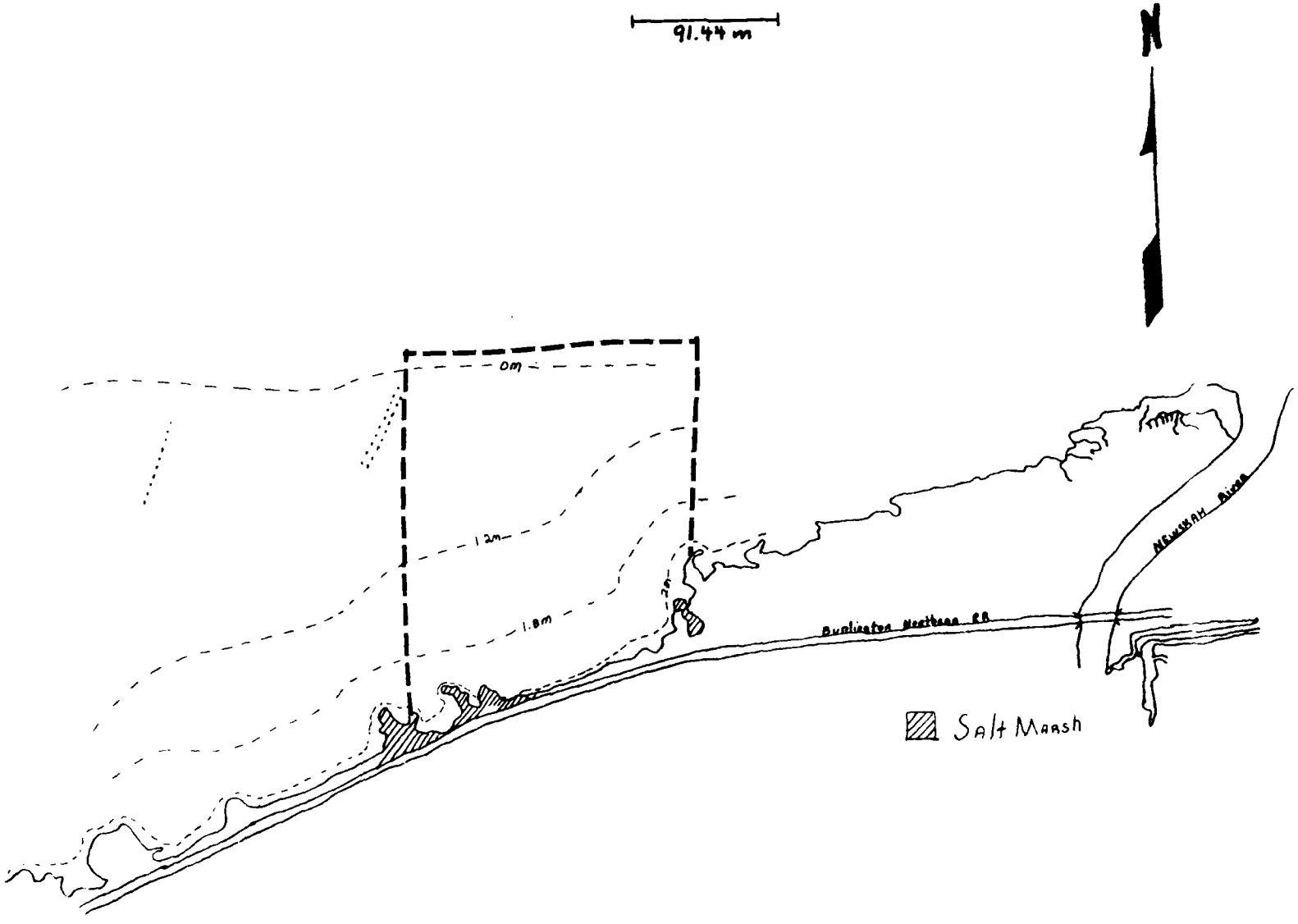


Figure 5. Distribution of salt marsh and approximate locations of elevations relative to M.L.L.W. at the marsh establishment site, Grays Harbor, Washington.

PART II

VEGETATION

METHODS AND MATERIALS

Quanitative measurement of cover types made during this study included edge and density. Area of each cover type was measured on 1-24,000 aerial photos using a dot grid. Density was measured with a density board at distances of 9 m and 20 m from the observer (Giles 1969: 142). The technique consists of marking a board 1.8 m long in 0.3 m sections, alternating between black and white, and numbering them 1 to 6 bottom to top. The numbers visible when the board is 9 m and 20 m from an observer are added together. This yields a minimum density of 21 when the entire board is visible and 0 when no numbers are readable. Edge was also measured on aerial photos using a technique described by Schueholz (1981). Basically, this technique provides a means of comparing habitat interspersion between different areas.

Specimens of the most common plant species were collected and identified to species.

RESULTS AND DISCUSSION

The disposal areas have diverse plant communities. Species associated with both wetlands and uplands occur on many sites (Table 1). Most of the vegetation is ground cover with shrubs and small trees. This [illegible] to [illegible] undergrowth with

Table 1. Plant species found on Junction City study area during 1980-81.

Common Name	Site 1	2	3	4	5	5B	6	7	8	9
sword fern	u	c	u			c		c	u	
bracken fern	u							u	u	
lady fern	c							c		c
Colorado blue spruce	u									
Sitka spruce	c		c	u	u		u	c		c
Western hemlock	c									
Cat-tail			u	c	c	c	c		c	c
small-fruited bullrush				c	c	c				
Lyngby's sedge				u	c			c	c	
slough sedge	c			c	c	c		c	c	c
skunk cabbage	c	u	c	c		u	c	c	c	u
lesser duckweed					u		u			c
soft rush					c	c	c			c
yellowflag				c	u		u			
Hooker's willow				c	u	u	c			
red alder	c	c	c	c			c	c		c
western dock	a									
straggely gooseberry			c	c			c			
hardhack	u		u			u	u		u	u
cinquefoil				c		c	c			
Pacific silverweed				c		c	c		c	c
ninebark	c									

Table 1 continued.

Common Name	Site 1	2	3	4	5	5B	6	7	8	9
evergreen blackberry	c	c		u			c	c		u
thimbleberry	c									
salmonberry	c	c	c	c	u	c	c	c	c	c
Pacific blackberry			u							
Nootka rose				c			c			
western crabapple				u		u				
foamflower	a									
giant vetch				c	u	c				c
vine maple	c						c		u	
cascara	c			c			c	c		c
Watson's willow-herb	a									
cow parsnip				c		u				
Pacific hemlock										
berula	a									
salal	u		c	c				c		u
red huckleberry	c			c			u			u
field mint				u			u			
American brooklime	a									
cleavers	a									
red elderberry	c		c					c		
bearberry honeysuckle	c	u		c			c	c		u
Douglas' aster				c		u	u			u
Pearly everlasting	u			c		c				
Canadian thistle	c									

a Known to occur on these sites but not found.
c Commonly found.
u Usually found but not widespread.

limited visibility. This was graphically shown with the dramatic change in density reading from summer ($\bar{y}$ = 9.35) to winter ($\bar{y}$ = 15.3) at 9 meters (Table 2). This is more obvious at 20 m when density went from 2.67 (summer) to 0.14 (winter).

Sites 1 and 2 had little vegetation between .3 and .9 m above the ground. This caused a "tunnel" effect, between these two heights. Because of the limited visibility on the Junction City study area, very few animals were actually observed.

Cover types were divided into four main classes: fresh water marsh, shrub swamp, mature forested swamp, and uplands. Most of the proposed disposal sites are wetlands (eg. shrub swamp)(Fig. 6). For a detailed description of cover types, see Appendix A. Cover types in this area show much interspersion with at least one edge interface every 1.94 hectares with an average of one interface every 1.3 hectares (Table 3). What this means, is that several different habitats were close together creating a situation that is generally advantageous to wildlife.

Table 2. Plant density values based on density board determinations on ten study sites located east of Junction City, Washington, during September 1980 and January 1981.

Meters	Sites 1 Sept	1 Jan	2 Sept	2 Jan	3 Sept	3 Jan	4 Sept	4 Jan	5 Sept	5 Jan
9	[illegible]	[illegible][a]	4.8	14.3	a		2.8	19.3	b	
20	[illegible]	[illegible]	0	1.0			2.8	11.3		

Meters	6B Sept	6B Jan	6 Sept	6 Jan	7 Sept	7 Jan	8 Sept	8 Jan	9 Sept	9 Jan
9	[illegible].3	[illegible].8	[illegible]	11.8	a		c		13.8	18.8
20	.3	[illegible]	[illegible]	6.8					[illegible].8	13.5

Meters	Loop Sept	Loop Jan
9	[illegible]	[illegible]
20	[illegible]	[illegible].14

a - Average of two readings at each site.
b - Sites similar to site 1.
c - Density not determined for this site.
d - Site similar to site.

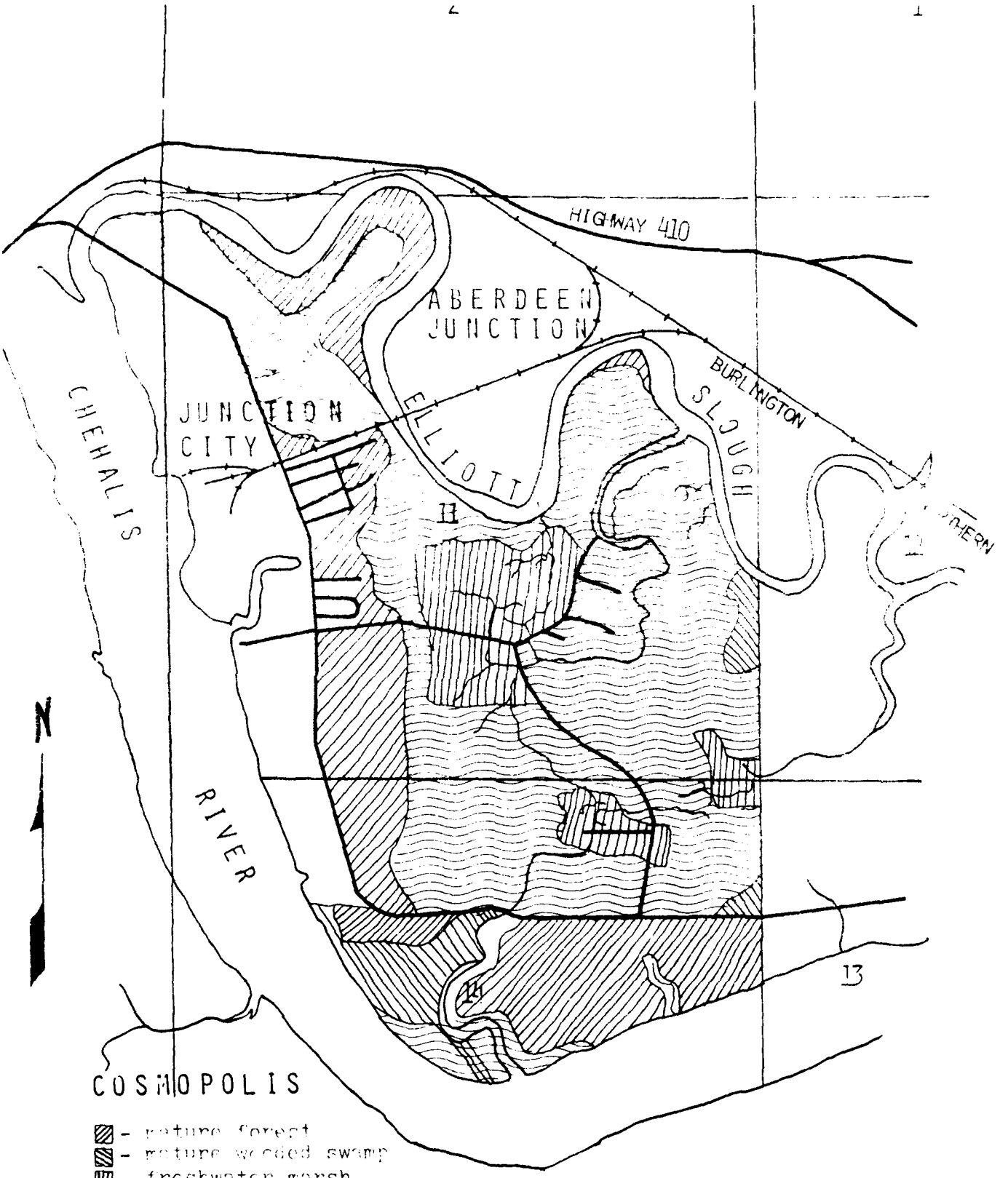


Fig. 6. Distribution of four major cover types on [illegible] study sites.

Table 3. Location and characteristics of ten study sites located east of Junction City, Washington.

Fill Site	Edge value[a] Ha/point	Study Site	Cover Type[b]	Area (Hectares)
16	0.86	7	MF	16.8
16	-	8	SS	5.3
17	1.56	4	SS	8.4
17	-	5	M	6.5
17	-	5B	M	5.6
17	-	6	SS	6.5
17	-	9	SS	10.2
18	1.06	1	MFS	10.9
18	-	2	MAF	1.9
18	-	3	MF	11.2

[a] Number of hectares encountered per edge between cover types for each designated fill area (16, 17, and 18).

[b] MFS = mature forested swamp; MAF = mature alder forest; SS = shrub swamp/pole regeneration; M = marsh; MF = mature forest.

PART III

AMPHIBIANS AND REPTILES

METHODS AND MATERIALS

Surveys were conducted in microhabitats preferred by amphibians and reptiles (eg. logs, debris) on sites 1, 2, 3, 4, 5B, 6, and 9. Data from surveys were supplemented with data from pit traps (eg., no. 1½ and 2 cans) placed at 1.5 m intervals along both sides of a 15 m long drift fence (Fitzner et al. 1978). The drift fence consisted of a plastic sheet 0.45 m wide staked at 1.5 m intervals. Bark chips were placed along the length of the fence to hold it in place on the matted vegetation.

RESULTS AND DISCUSSION

Three species of frogs, two species of salamanders and one species of newt were captured on these sites and identified (Table 4). The spotted frog and Dunn's salamander are new sightings in Grays Harbor County. A total of eight species of salamanders and six species of frogs are known to occur in Grays Harbor county (Slater 1964).

One species of lizard, one species of turtle and three species of garter snakes are known to occur in Grays Harbor county (Slater 1963). All three species of garter snakes were found during this study (Table 4).

Incidental to sampling for reptiles and amphibians, four species of fish were captured and identified on these sites. They were: shiner perch, three spine stickleback, reticulate

Table 4. Species of amphibians and reptiles captured during 1980-81 near Junction City, Washington.

Species	Number of Captures	Site(s)
Amphibians		
Pacific tree frog	4	1,5B,7,9
red-legged frog	3	3,9
spotted frog	1	1
Dunn's salamander	1	2
long-toed salamander	2	1,2,5B
rough-skinned newt	1	3
unidentified Bufo	1	1,2
Reptiles		
garter snake - common	1	9
garter snake - northwest	1	9
garter snake - red spotted	25	1,2,3,4,5B,6,7,8,9

sculpin, and Olympic mudminnow. The latter is restricted in distribution and is found only in the Clympic peninsula north of the Chehalis River.

Individuals of amphibians and reptiles would be eliminated by dredged material disposal.

PART IV

BIRDS

METHODS AND MATERIALS

AVIAN POPULATION SAMPLING IN WETLANDS

Passerine Birds

Transects, 137-457 m long, were established at study sites 1, 2, 4, 5, 5B, 6, 7, 8 and 9 that represented all major habitat types within proposed dredge disposal sites 16, 17 and 18 (Fig. 2). Four stations were marked on each transect. Sites were sampled twice during nesting season (20 May - 7 July 1980), five times during fall migration (20 August - 7 October 1980) and winter (24 November 1980 - 5 March 1981), and once during early nesting season (1 May - 5 May 1981).

Population sampling was conducted during the first three hours of daylight, when birds are most active. During the nesting season, qualitative observations were obtained at all sites during afternoon and dusk.

Densities of all species present were determined by the variable circular plot method (Reynolds et al. 1980). Nesting bird numbers were calculated by doubling the number of singing males heard, then multiplying by 1.5 to compensate for birds that were present but not heard or seen (Emlen 1971). Fall and winter bird numbers were calculated by multiplying total birds observed by 1.2 (Emlen 1971).

Gallinaceous Birds

Ruffed grouse were sampled in early April 1981 using the drumming route census method (Hungerford 1953). One transect was established to sample all major habitat types in the study area. Ten stations were marked at 200 meter intervals. Brewer (1980) found 100 meters to be the maximum distance for hearing ruffed grouse in western Washington. Sampling was conducted between 0445 and 0630 hours. The transect was walked twice, in opposite directions. Ruffed grouse densities were determined by multiplying the male grouse densities by two (Rusch and Keith 1977, Gullion and Marshall 1968). Total densities were determined by $D = \frac{\frac{1}{2}(XY)}{N}$

D = Bird density expressed in hectares per bird

X = Number of listening stations censused

Y = Area of each listening station
(calculated to be 3.14 hectares)

N = Number of grouse heard drumming
(from Brewer 1980).

Owls

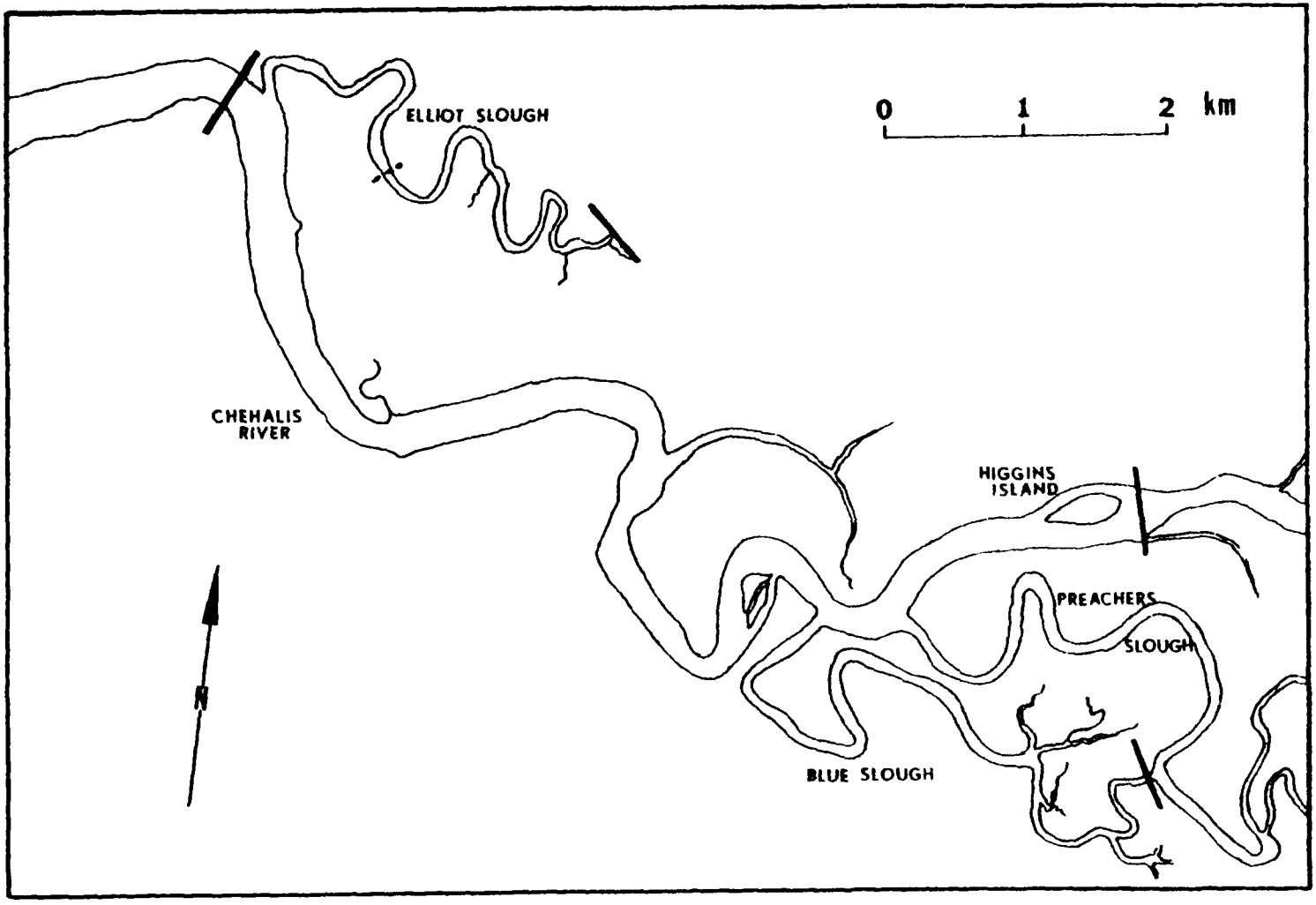
Nesting owls were sampled from 19 February to 30 April 1981 using taped calls to induce owls to respond. Two transects were established with five stations marked on each transect. Stations were at least 400 meters apart to avoid overlap of

auditory detections. The first transect was two kms long and followed the old Central Park road, from Higgins Slough east. It passed through a mature mixed-forested swamp. The other transect was in the Junction City study area. All other major habitat types were sampled from this transect.

Both transects were sampled three times for three hours each, starting one hour after sunset. At each station I would listen for five minutes, play four sets of screech owl calls spaced 30 seconds apart, wait three minutes and repeat method with pygmy owl and saw-whet owl calls. After completing the transect, I reversed direction and used long-eared owl, great horned owl, and spotted owl calls. For every owl heard, the compass bearing to the owl was recorded, and its distance from the transect estimated.

Water Birds

Water-related birds were censused from a boat on the Chehalis River and sloughs proximal to proposed dredging activity (Fig. 7). Counts were conducted three times per month from September - November 1980, twice per month from December 1980 to March 1981, and once in April 1981. Kilometers of river censused approximately equaled kms of sloughs censused (Table 5).



[illegible]. 7. [illegible] Chehalis River, Blue Slough and Elliot Slough censused by [illegible] - April [illegible].

Table 5. Number of kilometers censused in Chehalis River area.

Location	kms censused
Chehalis River	11.3
Elliot Slough	2.1 - 4.4[a]
Blue Slough	5.8

[a] Varied with tide elevation

Counts were alternated between early morning and late afternoon. Initially (September - October 1980), counts were conducted at low tide. All other censuses were conducted at peak high tide when bird use was found to be highest.

Records were kept of date, time, weather, tide level. The number of birds per species and the activity of each bird was also noted. Observations allowed analyses of seasonal abundance and habitat preference.

AVIAN POPULATION SAMPLING IN GRAYS HARBOR

Baseline data from the salt marsh establishment area were collected between June 1980 and May 1981. Methods used were similiar to those of Smith and Nudd (1976) tideflat sampling methods. Blinds were built overlooking the marsh establishment site (K)

and a marsh control site (MC)(Fig. 8). At each site an eight ha plot was delineated using reinforcing bars and saplings. Both plots had 300 meters of shoreline and extended to the edge of the south channel (MLLW).

Counts were conducted an average of 5 times per month. During sampling, each site was approached quietly and as quickly as possible. All birds using the sample plot were recorded. Binoculars and a 15-60 variable power spotting scope aided observations. Records were kept on date, time, weather, tide level, species and activity. Also, all birds observed in the inner harbor were recorded.

One of the reasons for this study was to compare avian use of sites M and MC. The effect of variables (time of day, weather, and tideflat exposed) were kept to a minimum by counting birds on both sites within one hour. Since site MC was at a higher elevation than site M, birds on site MC were censused at the higher tide level on a given day. Thus, the amount of tideflat exposed was equal at both sites. Counts were conducted at all tide levels (eg. high, low, incoming, outgoing) so all birds using the sites would be adequately sampled.

A transect, 60 m long, was established in the mature mixed-forested swamp (site 10) adjacent to site M. Breeding birds were sampled using the previously described variable circular plot method. Birds were sampled qualitatively during all other seasons.

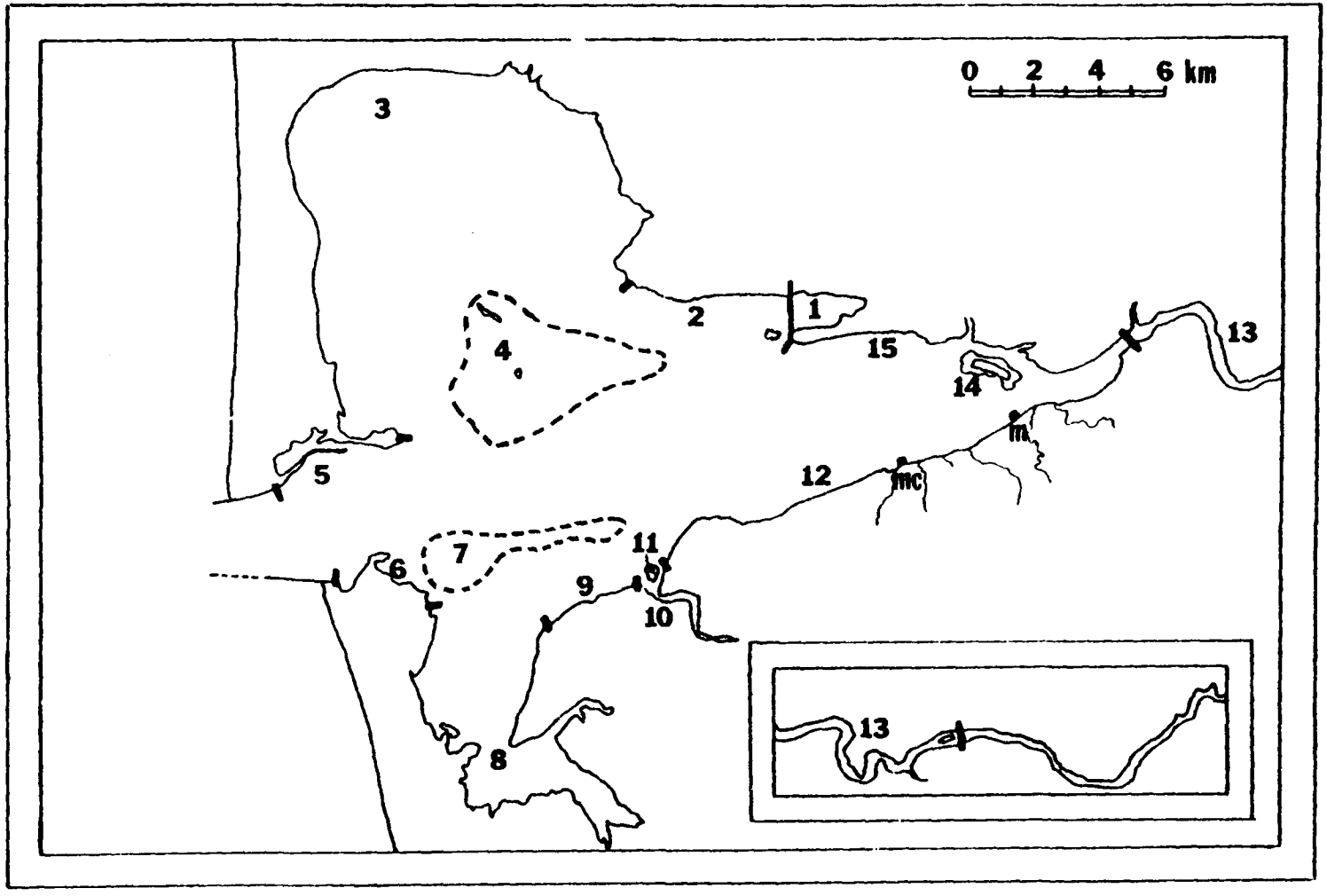


Figure 8. Subdivisions of Grays Harbor used during aerial censuses, November 1985 - May 1991.

Between 25 November 1980 and 13 May 1981, cooperative flights with the U.S. Fish and Wildlife Service were conducted on Grays Harbor. Censuses were conducted from a Cessna 182 or 206 at altitudes between 15 and 60 meters. The average speed was 165 kms per hour. Flight duration was 1 - 1.5 hours.

Flights were conducted during high tides (2.2 - 3.1 meters relative to MLLW) when ducks and shorebirds concentrated around shorelines and islands in the estuary. Waterfowl and shorebirds received the most comprehensive coverage. Diving birds (eg. loons, grebes, scoters, mergansers) were incompletely counted because they disperse over the entire harbor. Many observers have found diving birds difficult to count from airplanes (Yocom and Keller 1961, Smith and Mudd 1976).

The area censused included the entire shore of the estuary, the mid-harbor islands, and the Chehalis River upstream to Higgin's Island. During censuses, the harbor was subdivided into 14 sites (Fig. 8)(Table 6). This permitted an analysis of site preference or avoidance. First, the length of shoreline of each site was calculated. Then, the length of the harbor shoreline represented by each site was compared to the number of selected waterfowl and shorebird species observed at each site to arrive at birds/km of shoreline index.

Flocks of birds were photographed on several occasions to

Table 6. Areas of Grays Harbor and percentage of total shoreline represented by each area censused during flights, November 1980 - May 1981.

Area	Name	Percentage of shoreline of Grays Harbor
1	inner Bowerman basin	3.0
2	outer Bowerman basin and Little Moon Island	3.3
3	North bay	17.1
4	Sand Island, Goose Island, and spits	6.5
5	Ocean Shores and Oyehut sink[a]	6.3
6	Westport	2.8
7	Whitcomb flats	4.1
8	South bay	26.4
9	Ocosta ("bottle beach")	2.3
10	Johns River	6.6
11	Markham Island	1.6
12	south shore, inner harbor	10.1
14	Rennie Island	3.1
15	north shore, inner harbor	6.8
		100.0

[a] Oyehut Wildlife Area

compare estimates of bird numbers made during flights with actual numbers determined from photographs. This information was used to calculate correction factors based on a comparison of these two figures. Estimated bird numbers were then multiplied by the correction factor to arrive at a figure closer to the actual numbers of birds present.

Food Habits

Between October 1980 and March 1981, a food habits study was conducted on Grays Harbor. It was initially designed to study feeding habits of shorebirds and waterfowl using the marsh establishment and marsh control sites. Because so few birds were observed along the entire south shore of the inner harbor, the collection area was expanded in January 1981 to include the north and south bays.

A literature review of food habits techniques made it obvious that analysis of esophagus contents would yield the most accurate data in an estuarine environment. Studies have demonstrated the bias of gizzard analysis toward hard food items (Swanson and Bartonek 1970, Dillery 1965).

Techniques used for collecting and preparing bird specimens for food habits analysis from Smith and Mudd (1976) were as follows.

Birds were shot after they had been observed feeding for at least five minutes. The esophagus was dissected from each bird and preserved in formalin solution. Each esophagus was placed in a separate vial with a tag giving date, location, species of bird and identification number. If any birds were left after five minutes which had not had their esophagus removed they were discarded. In the lab, the esophagus was cut lengthwise and contents were removed. Food particles were identified, counted, and stored in 70% alcohol glycerin solution.

All nomenclature on birds in this report follows the American Ornithologists' Union Checklist of the Birds of North America (1957). Nomenclature has been updated according to unpublished supplements provided by Robbins et al. (pers. comm. with publisher[1]).

[1] Current address: Golden Press, New York, New York.

RESULTS AND DISCUSSION

JUNCTION CITY

Proposed dredge disposal sites 16, 17 and 18 are composed of many types of wetland habitats, with edge and multi-storied canopies being characteristic features. Small sloughs meander throughout the area, providing habitat for fish-eating birds and waterfowl. Many marshes support waterfowl, herons, rails, and sandpipers. The shrub-sized vegetation provides dense cover for nesting birds, and year-round feed for many birds. Tall conifers and alders, dispersed throughout the area, provide perches for raptors and singing birds. Mature mixed-forested swamps support birds associated with mature forests and uplands (accipiters, owls, grouse, woodpeckers).

Ninety species were observed using the wetlands within proposed dredge disposal sites 16, 17, and 18 (Tables 7 - 15). Of these, 18 are in groups directly associated with wetlands (grebes, cormorants, waterfowl, herons, rails, sandpipers and kingfishers). Four passerine species associated with wetlands were present (**willow flycatcher, long-billed marsh wren, red-**winged blackbird, common yellowthroat). Passerines accounted for 40 of the species observed. Passerines occurred in high densities during every season (Table **16**).

Passerines

Dense vegetation caused some problems during population

Table 7. Species and mean densities (birds/ha) observed on Site 1, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Raptors												
Red-tailed Hawk								X				
Sharp-shinned Hawk					X							
Screech Owl		X			X							
Pygmy Owl		X										
Gallinaceous birds												
Ruffed Grouse	6	0.5	0.3		X			X				
Pigeons												
Band-tailed Pigeon								X				
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird	4	3.0	3.5		X							
Woodpeckers												
Common Flicker								X			X	
Pileated Woodpecker					X			X				
Hairy Woodpecker					X							
Downy Woodpecker								X				
Passerines												
Barn Swallow					X							
Steller's Jay				3	0.3	0.6	9	0.3	0.7	4	0.1	0.3
Common Crow					X			X				
Black-capped Chickadee	14	3.7	1.2	8	1.5	2.1	11	0.8	1.5	6	0.5	1.5

Table 7 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[d]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Chestnut-backed Chickadee					X			X				
Bushtit					X		5	0.4	1.7			
Brown Creeper					X							
Winter Wren	8	4.7	1.7				21	2.7	3.1	23	3.0	2.9
Bewick's Wren											X	
Long-billed Marsh Wren		X										
American Robin	9	3.3	0.7	8	1.9	3.5	4	0.1	0.4			
Varied Thrush	6	1.2	0.8							6	0.4	1.8
Swainson's Thrush		X		43	6.0	2.5		X				
Golden-crowned Kinglet	23	12.9	3.5	11	3.7	3.5	74	6.3	6.2	34	5.6	15.6
Ruby-crowned Kinglet					X		3	0.2	1.0	10	1.6	5.8
Cedar Waxwing					X							
Orange-crowned Warbler				4	2.1	4.5						
Townsend's Warbler	14	2.8	11.4									
Wilson's Warbler	6	2.3	2.7	26	5.2	4.4						
Purple Finch					X							
House Finch					X							
Pine Siskin	8	1.9	3.9							220	11.7	52.2
Dark-eyed Junco					X						X	
Fox Sparrow										6	1.3	3.4
Song Sparrow	8	2.1	1.3	32	6.0	3.3	23	1.9	1.9	20	2.1	2.5
Total species[e]		13			25			17			12	

[a] n (number stations sampled) = 4

[b] n = 9

[c] n = 20

[d] $\bar{x}$ = mean number birds/ha, SD = Standard deviation

[e] Total species, entire study = 37.

Table 8. Species and mean densities (birds/ha) observed at site 2, May 1980 - May 1981.

T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[d]	x̄	SD	T	x̄	SD	T	x̄	SD	T	x̄	SD
Fish-eating waterbirds												
Northern Green Heron					X			X				
Great Blue Heron								X				
Waterfowl												
Mallard					X			X		12	0.5	1.8
American Green-Winged Teal										6	0.3	1.4
Wood Duck					X					5	0.3	1.7
Raptors												
Red-Tailed Hawk					X			X				
Gallinaceous birds												
Ruffed Grouse					X			X		3	1.6	4.4
Goatsuckers												
Common Nighthawk					X							
Woodpeckers												
Downy Woodpecker								X			X	
Passerines												
Willow Flycatcher					X							
Steller's Jay					X		3	0.4	1.2	3	0.3	1.1
Common Crow												
Black-capped Chickadee					X		6	1.0	3.8	28	8.6	40.8
Chestnut-backed Chickadee										4	0.7	3.8
Bushtit							15	1.5	3.6			
Winter Wren	2	1.5	3.0				15	1.3	2.6	28	5.4	6.0
Bewick's Wren										3	0.6	2.2
American Robin				14	1.9	2.2						

Table 8 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[d]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Swainson's Thrush				23	5.9	4.6						
Golden-crowned Kinglet		X					7	1.0	2.6	32	10.9	50.9
Ruby-crowned Kinglet					X					42	8.7	27.6
Cedar Waxwing								X				
Black-throated Gray Warbler								X				
Wilson's Warbler	4	1.9	3.9	16	2.7	2.9						
Purple Finch					X							
Pine Siskin										255	67.9	243.9
Rufous-sided Towhee							4	0.6	1.8		X	
Fox Sparrow										12	2.1	5.0
Song Sparrow		X		6	1.4	2.2	12	1.9	2.1	12	2.1	3.1
Total species[e]		4			15			15			16	

[a] n (number stations sampled) = 4.

[b] n = 9

[c] n = 20

[d] See Table 8.

[e] Total species, entire study = 29.

Table 9. Species and mean densities (birds/ha) observed on site 4, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T[e]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Fish-eating waterbirds												
Western Grebe											X	
Great Blue Heron								X			X	
Northern Green Heron					X			X				
Belted Kingfisher								X			X	
Waterfowl												
Mallard					X					4	0.3	1.2
Blue-winged Teal					X							
American Green-winged Teal								X		4	0.2	0.
Raptors												
Red-tailed Hawk											X	
Gallinaceous birds												
Ruffed Grouse					X							
Shorebirds												
Common Snipe											X	
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird	6	5.1	4.5	6	1.8	3.9						
Woodpeckers												
Common Flicker					X			X		4	0.1	0.4
Pileated Woodpecker								X				
Downy Woodpecker											X	

Table 9 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Passerines												
Willow Flycatcher				18	4.2	3.0		X				
Barn Swallow					X							
Violet-Green Swallow					X							
Tree Swallow					X							
Rough-Winged Swallow					X							
Steller's Jay					X		11	0.6	1.2		X	
Common Crow					X							
Black-Capped Chickadee	12	4.9	4.7	6	1.2	2.1	8	0.5	1.2	20	1.3	3.4
Bushtit	8	3.7	7.7							45	.9	19.3
Winter Wren								X			X	
Long-Billed Marsh Wren	4	0.9	1.1		X			X				
American Robin	12	1.5	0.9	7	1.3	1.8	37	1.9	3.3	4	0.1	0.3
Varied Thrush											X	
Swainson's Thrush				32	3.8	2.2		X				
Golden-Crowned Kinglet							4	0.3	1.4	12	.4	4.7
Ruby-Crowned Kinglet	4	0.7	1.5					X		32	.3	8.
Cedar Waxwing				6	1.1	2.7	38	1.4	2.9			
Starling							37	0.5	2.3			
Orange-Crowned Warbler	8	2.7	2.3	19	2.6	2.8						
Nashville Warbler								X				
Yellow Warbler					X							
Yellow-Rumped Warbler							10	1.5	4.0			
Townsend's Warbler								X				
Black-Throated Gray Warbler								X				
Common Yellowthroat	8	4.3	4.8	20	3.5	3.8	7	1.3	2.6			
Wilson's Warbler	6	2.5	2.5					X				
Brown-Headed Cowbird					X							
Purple Finch	2	0.7	1.1	6	1.7	1.5	3	0.4	1.7			
House Finch	4	0.7	0.9		X							

Table 9 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
American Goldfinch					X							
Rufous-Sided Towhee								X		3	1.4	1.4
White-Crowned Sparrow							3	0.4	1.2			
Golden-Crowned Sparrow							4	0.8	2.4			
Fox Sparrow							4	0.6	1.3	4	1.0	4.3
Song Sparrow	12	2.9	1.7	20	5.4	7.6	22	2.2	2.3	34	3.1	2.9
Total species[f]		12			28			29			12	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 18

[d] n = 20

[e] See note d, Table 8.

[f] Total species, entire study = 51.

Table 10. Species and mean densities (birds/ha) observed on site 5, May 1980 - May 198 . T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season using site for non-nesting reasons.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T[e]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Fish-eating waterbirds												
Great Blue Heron					X			X		3	0.5	1.4
Northern Green Heron					X			X				
Black-crowned Night Heron					X							
American Bittern	2	0.5	1.1	2	1.3	1.6		X		6	0.5	1.3
Belted Kingfisher								X			X	
Waterfowl												
Mallard					X		11	1.0	2.5	13	1.2	2.7
Blue-winged Teal				8	2.4	4.1						
American Green-winged Teal		X						X		70	4.7	8.4
Cinnamon Teal		X			X							
Wood Duck					X							
Bufflehead								X				
Raptors												
Red-tailed Hawk								X			X	
Cooper's Hawk								X				
Sharp-shinned Hawk											X	
Great Horned Owl								X				
Rails												
Virginia Rail	4	0.9	1.1	4	2.7	4.9	3	0.7	1.5	4	0.3	1.0
Sora				2	1.5	2.8						
Shorebirds												
Killdeer					X			X				
Spotted Sandpiper					X							
Common Snipe		X		4	2.7	4.9	2	0.3	0.9	9	1.2	3.3

Table 10 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird					X							
Woodpeckers												
Common Flicker					X			X			X	
Pileated Woodpecker								X				
Downy Woodpecker					X			X			X	
Passerines												
Barn Swallow					X			X				
Violet-green Swallow					X			X				
Tree Swallow					X							
Rough-winged Swallow					X			X				
Common Crow					X			X			X	
Northwestern Crow					X							
Black-capped Chickadee		X								7	0.7	2.1
Bushtit					X		8	0.8	3.1	3	0.3	1.6
Bewick's Wren											X	
Long-billed Marsh Wren	26	8.5	4.1	37	6.6	4.8	44	5.1	2.8	81	7.1	3.7
American Robin					X		25	1.5	2.9			
Varied Thrush								X				
Golden-crowned Kinglet										21	3.1	7.7
Ruby-crowned Kinglet										18	3.2	17.1
Cedar Waxwing					X			X				
Nashville Warbler								X				
Yellow-rumped Warbler							17	1.6	3.1			
Common Yellowthroat	4	0.9	1.1	2	0.3	0.9	11	0.9	1.5			
Red-winged Blackbird	20	4.7	3.1	58	11.1	11.1	180	10.1	20.0	80	3.5	4.1
Purple Finch					X							
American Goldfinch					X							

Table 10 **Continued.**

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Rufous-sided Towhee								X				
Fox Sparrow								X				
Song Sparrow					X		30	1.3	1.6	9	0.9	1.5
Total species[f]		9			32			32			20	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 16

[d] n = 20

[e] **See note d, Table 8.**

[f] **Total species, entire study = 49.**

Table 11. Species and mean densities (birds/ha) observed on site 5B, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[d]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Fish-eating birds												
Double-crested Cormorant								X				
Great Blue Heron								X			X	
Northern Green Heron								X				
American Bittern								X				
Belted Kingfisher								X			X	
Waterfowl												
Mallard								X		5	0.5	2.7
American Green-winged Teal								X				
Raptors												
Red-tailed Hawk								X			X	
Gallinaceous birds												
Ring-necked Pheasant					X			X				
Rails												
Virginia Rail								X				
Shorebirds												
Killdeer					X						X	
Pectoral Sandpiper								X				
Common Snipe								X			X	
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird		X										

Table 11 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Woodpeckers												
Common Flicker		X						X				
Passerines												
Willow Flycatcher				8	0.7	2.1						
Barn Swallow					X			X				
Violet-green Swallow					X							
Tree Swallow					X							
Steller's Jay					X		6	0.7	1.5			
Common Crow					X						X	
Black-capped Chickadee					X					9	0.8	2.1
Bushtit					X		10	0.7	2.1			
Winter Wren								X		6	0.6	1.4
Bewick's Wren							3	0.5	1.4			
Long-billed Marsh Wren	8	2.5	2.3		X		10	1.0	1.8		X	
American Robin	9	2.1	1.8	10	3.7	3.6	16	1.1	2.6		X	
Swainson's Thrush				19	2.4	1.5		X				
Golden-crowned Kinglet										8	1.4	7.6
Ruby-crowned Kinglet										8	1.0	2.8
Cedar Waxwing					X							
Orange-crowned Warbler	10	3.3	3.3	10	1.5	2.1		X				
Yellow-rumped Warbler								X				
Common Yellowthroat	12	5.3	2.4	30	5.5	7.6	22	1.4	1.6			
Wilson's Warbler		X			X							
Red-winged Blackbird		X										
Brown-headed Cowbird					X							
Black-headed Grosbeak					X							
Purple Finch					X			X				
Rufous-sided Towhee								X				
Dark-eyed Junco							5	0.6	2.7			

Table 11 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
White-crowned Sparrow							5	X 0.7	2.1			
Golden-crowned Sparrow												
Fox Sparrow							38	X 4.1	3.3	36	2.9	3.9
Song Sparrow	12	6.1	3.1	24	4.6	3.7						
Total species[e]		9			22			32			16	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 20

[d] See Table 8.

[e] Total species, entire study = 47.

Table 12. Species and mean densities (birds/ha) observed on site 6, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[a]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Fish-eating waterbirds												
Belted Kingfisher								X			X	
Waterfowl												
Mallard								X				
American Green-winged Teal								X			X	
Raptors												
Red-tailed Hawk								X			X	
Rails												
Virginia Rail					X							
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird	6	3.9	2.5	6	4.8	8.5						
Woodpeckers												
Common Flicker		X			X		3	0.1	0.3		X	
Passerines												
Willow Flycatcher				18	2.7	1.8						
Barn Swallow					X							
Violet-green Swallow					X							
Tree Swallow					X							
Steller's Jay					X		11	0.3	0.6		X	
Common Crow					X						X	
Black-capped Chickadee	4	1.2	1.3	6	0.4	0.6		X		25	2.5	8.7

Table 12 **Continued.**

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Bushtit					X		28	5.4	20.9	7	0.7	3.7
Winter Wren							4	0.4	1.6	7	0.7	3.7
Bewick's Wren											X	
Long-billed Marsh Wren		X										
American Robin	7	1.7	1.8	11	1.3	1.2	23	0.9	1.2	5	0.3	1.1
Hermit Thrush											X	
Swainson's Thrush				42	4.3	1.8	6	0.7	1.5			
Golden-crowned Kinglet							13	2.2	5.0	17	2.1	7.0
Ruby-crowned Kinglet	8	4.1	3.5				6	1.3	4.1	38	4.9	11.7
Cedar waxwing					X		18	1.5	3.7			
Starling							18	0.2	1.1			
Orange Warbler	6	1.7	1.3	6	0.5	0.9						
Yellow-rumped Warbler							19	1.5	2.9			
Common Yellowthroat		X						X				
Wilson's Warbler	4	1.9	2.5		X			X				
Red-winged Blackbird	3	1.3	2.5		X							
Brown-headed Cowbird					X							
Black-headed Grosbeak					X							
Purple Finch	7	3.0	2.3	12	1.5	1.6		X		10	0.7	2.9
House Finch	8	2.5	3.7					X				
American Goldfinch					X							
Rufous-sided Towhee								X		3	0.2	0.7
Fox Sparrow										6	2.1	5.2
Song Sparrow	14	4.3	1.5	10	2.4	3.7	17	2.3	2.8	22	2.3	2.9
Lincoln's Sparrow		X										
Total species[e]		14			24			22			18	

[a] n(number stations sampled) = 4

[b] n = 2

[c] n = 20

[d] **See Table 8.**

[e] **Total species, entire study = 41.**

Table 13. Species and mean densities (birds/ha) observed on site 7, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season using site for non-nesting reasons.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T[e]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Raptors												
Cooper's Hawk					X							
Rails												
Virginia Rail								X				
Pigeons												
Band-tailed Pigeon								X				
Goatsuckers												
Common Nighthawk					X							
Woodpeckers												
Common Flicker		X			X			X			X	
Hairy Woodpecker					X							
Passerines												
Tree Swallow					X							
Steller's Jay					X							
Common Crow	3	7.3	4.5		X							
Black-capped Chickadee					X			X		12	0.9	2.9
Chestnut-backed Chickadee								X			X	
Bushtit					X					20	2.0	10.6
Brown Creeper				8	1.9	2.5						
Winter Wren	4	3.2	5.1				11	2.4	3.9	10	2.0	3.5
Bewick's Wren											X	
Varied Thrush										3	0.5	2.0
Swainson's Thrush				19	3.4	3.9						
Golden-crowned Kinglet	7	3.1	4.7	2	0.4	1.2	35	5.0	6.4	42	4.3	8.7
Ruby-crowned Kinglet					X		4	0.6	2.4	14	2.1	4.1

Table 13 **Continued.**

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Warbling Vireo					X							
Yellow-rumped Warbler							3	0.5	1.8			
Townsend's Warbler											X	
Wilson's Warbler	6	4.5	5.7	5	1.4	2.2						
Rufous-sided Towhee								X			X	
Song Sparrow	6	3.9	2.9	14	3.1	3.6	8	2.5	3.6	10	1.4	2.6
Total species[f]		6			16			11			12	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 16

[d] n = 20

[e] **See note d, Table 8.**

[f] **Total species, entire study = 25.**

Table 14. Species and mean densities (birds/ha) observed on site 8, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T[e]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Raptors												
Cooper's Hawk					X							
Rails												
Virginia Rail								X				
Shorebirds												
Common Snipe											X	
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird	2	2.7	5.4	4	5.3	10.5						
Passerines												
Steller's Jay					X			X				
Common Crow					X					7	0.7	3.7
Black-capped Chickadee		X			X		26	5.0	7.7	16	2.2	8.2
Chestnut-backed Chickadee							8	3.7	9.7		X	
Bushtit					X		7	1.2	3.4	45	4.5	24.0
Brown Creeper					X							
Winter Wren	2	1.0	2.0				5	0.9	1.6	3	0.6	2.3
Bewick's Wren								X				
American Robin					X			X			X	
Swainson's Thrush				5	0.5	1.0						
Golden-crowned Kinglet	2	1.5	3.0		X		37	5.8	7.6	70	8.4	22.1
Ruby-crowned Kinglet	2	1.5	3.0		X					12	2.1	11.8
Cedar Waxwing					X							
Orange-crowned Warbler		X		10	2.6	4.0						

Table 14 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[d]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Nashville Warbler	2	1.5	3.0		X							
Townsend's Warbler											X	
Black-throated Gray Warbler		X										
Common Yellowthroat	10	5.3	4.9	16	1.8	2.7	3	0.8	2.4			
Wilson's Warbler	8	5.4	1.1	23	7.5	6.8						
Purple Finch					X					11	1.9	10.
American Goldfinch					X			X				
Song Sparrow	3	4.1	5.1	20	6.0	7.5	4	0.5	1.2	22	2.7	3.
Total species[f]		11			20			12			12	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 16

[d] n = 20

[e] See note d, Table 8.

[f] Total species, entire study = 27.

Table 15. Species and mean densities (birds/ha) observed at site 9, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T[d]	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Fish-eating waterbirds												
Great Blue Heron								X			X	
American Bittern					X			X				
Waterfowl												
Mallard					X			X				
Blue-winged Teal					X							
Raptors												
Red-tailed Hawk								X				
Cooper's Hawk					X			X				
American Kestral					X							
Screech Owl					X							
Gallinaceous birds												
Ring-necked Pheasant					X							
Shorebirds												
Common Snipe								X		7	1.3	4.1
Pigeons												
Band-tailed Pigeon								X				
Goatsuckers												
Common Nighthawk					X							
Hummingbirds												
Rufous Hummingbird	6	4.8	4.6	2	2.7	7.9						
Woodpeckers												
Common Flicker							6	0.2	0.7		X	

Table 15 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Passerines												
Willow Flycatcher				12	1.4	1.6						
Barn Swallow					X							
Violet-green Swallow					X							
Steller's Jay					X		8	0.5	0.7			
Common Crow					X							
Black-capped Chickadee	10	2.1	1.7	5	0.8	1.3	9	0.7	1.8	12	1.4	5.0
Bushtit				4	2.4	7.1	9	0.8	2.5	28	4.9	26.5
Winter Wren							5	1.0	2.8	11	1.1	1.5
Bewick's Wren								X			X	
Long-billed Marsh Wren	8	7.1	5.4	9	3.3	4.6	9	1.4	2.7	5	1.3	3.4
American Robin	6	2.9	2.4	12	1.3	1.4	32	1.8	2.5		X	
Varied Thrush								X				
Swainson's Thrush				49	5.6	3.1		X				
Golden-crowned Kinglet											X	
Ruby-crowned Kinglet							6	0.9	2.4		X	
Cedar Waxwing					X			X				
Starling								X				
Orange-crowned Warbler	6	1.5	1.2	20	2.4	1.5						
Yellow-rumped Warbler										5	0.4	1.2
Townsend's Warbler										4	0.3	3.8
Common Yellowthroat	22	6.9	3.0	34	4.5	2.6	11	1.4	2.8			
Wilson's Warbler		X		6	0.5	1.1		X				
Red-winged Blackbird					X							
Brown-headed Cowbird					X							
Black-headed Grosbeak					X			X				
Purple Finch	8	1.9	1.7		X							
House Finch								X				
American Goldfinch					X							
Rufous-sided Towhee								X				
White-crowned Sparrow								X				

Table 15 Continued.

Species	Spring[a]			Nesting[b]			Fall[c]			Winter[c]		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Golden-crowned Sparrow							9	0.9	2.0			
Fox Sparrow								X			X	
Song Sparrow		X		12	2.8	3.5	20	2.8	2.7	25	1.7	2.(
Total species[e]		9			29			29			15	

[a] n(number stations sampled) = 4

[b] n = 9

[c] n = 20

[d] See note d, Table 8.

[e] Total species, entire study = 47.

16. Passerine species and total passerine densities observed seasonally Junction City wetland sites, May 1980 - May 1981.

Site	Spring[a]		Nesting[b]		Fall[c]		Winter[c]		Total
	Total species	Birds/ ha	Total species	Birds/ ha	Total species	Birds/ ha	Total species	Birds/ ha	
1	11	34.9	19	26.7	11	12.7	11	26.8	25
7	5	22.0	12	10.2	8	11.0	11	13.2	19
4	11	25.5	19	23.8	23	12.4	11	17.5	36
6	12	21.7	20	13.1	17	16.7	12	16.5	32
8	10	20.3	17	18.4	11	17.9	11	23.1	22
9	8	16.4	20	25.0	21	12.2	12	11.7	33
5	4	14.1	15	18.0	16	21.3	9	18.8	24
5B	7	19.3	17	18.4	19	10.8	10	6.7	31
2	4	3.4	9	11.9	9	7.7	11	107.3	20

[a] n (number stations sampled) = 4

[b] n = 9

[c] n = 20

sampling. First, since most identifications were made by sound, non-vocal birds were either undercounted or missed entirely. Second, flocking birds were consistently underestimated since some birds in a flock are silent. Third, sample sizes (individuals of one species observed from one station) for many species were small because visibility in these wetlands was limited by the dense vegetation. Population estimates of non-vocal bird species are low because the observer is relying on visual rather than audio clues for identification. This was more of a problem after the breeding season when many birds stop singing. Because of the above factor, I consider population estimates for birds in fall and winter to be low.

Highest species diversity occurred during nesting season (Table 16). High numbers of species were seen during fall migration as resident birds, migrating, and wintering birds shared the area. Pole sized mixed-forested swamps (Sites 4,6) supported the most passerine species on a yearly basis (Table 16). Shrub swamps (Sites 8,9) supported nearly the same number of passerine species. Shrub swamp use was best represented by Site 9. Site 8 was too small to be considered representative of shrub swamp use. Site 5B supported a similiar number of species. Site 5 was important to large numbers of few passerine species (mostly red-winged blackbirds, long-billed marsh wrens).

While comparing habitat use, one must consider the fact that Sites 4, 5, 5B, 6, 8 and 9 contained pole-sized mixed-forested swamp, shrub swamp, marsh, and edge between habitat types. Species that utilize any of these cover types are likely to be present. The only homogeneous habitat was site 1.

Mature mixed-forested swamp use was best represented by site 1. Site 7 was very small. Mature forests are important to nesting birds (Table 17). The multi-storied canopy and nesting holes of this habitat supported the most nesting species and highest densities. It also supported the most nesting passerine species and highest passerine densities. Pole stage mixed-forested swamps supported slightly more total nesting species, and passerine nesting species than shrub swamps. Densities were also higher for both groups in pole-staged swamps. Breeding densities in Table 17 are based on breeding season data (20 May - 7 July 1980) for most species, and spring data (1 May - 5 May 1981) for species that nest earlier in the year.

Seasonally, highest total passerine densities occurred at all sites, except 2 and 5, during breeding season. High densities occurred year-round, primarily due to migrating and wintering flocks of pine siskins, golden-crowned kinglets, bushtits, and black-capped chickadees. The average density of passerine bird species for the year (1980-81), on all Junction City sites, was 20 birds per ha. The average density of nesting passerine birds was 23 birds per ha.

Table 17. Number of species of birds and numbers of passerine bird species observed nesting on Junction City study sites, 1 May - July 1980.

Site	Total Nesting Species	Nesting Birds Per ha	Nesting Songbird Species	Nesting Songbirds Per ha	Total Species Observed[a]
1	23	38.0	16	34.8	31
7	12	13.4	10	13.4	17
4	18	35.9	14	30.8	31
6	15	26.3	12	22.4	29
8	12	26.6	11	23.9	20
3	16	30.9	12	28.2	29
5	11	28.6	4	18.0	34
5B	8	18.4	7	18.4	24
2	8	13.4	6	13.4	17

[a] Includes species using sites for non-nesting reasons (e.g. feeding, resting).

Waterfowl

Dabbling ducks were observed year-round using sloughs and marshes in the study area (Tables 7 - 15). Mallards, blue-winged teal, wood ducks, and cinnamon teal were observed nesting in marshes (Table 18).

Table 18. Pairs of nesting ducks observed at Junction City Sites.

Species	Site			
	2	4	5	9
Mallard	1	2	1	1
Blue-winged teal			3	
Wood duck	1			
Cinnamon teal			1	

Most use occurred during winter when American green-winged teal were abundant. During three sampling periods between 27 January and 5 April 1981, 68 American green-winged teal and 12 mallards were observed at the Site 5 marsh. This 10 ha marsh received 800 (range 600-930) waterfowl days of use per month (mean waterfowl observed times 30 days per month). During winter, small numbers of mallards and flocks of 5-20 green-winged teal were

consistently seen using a small pond near Site 2, and sloughs on Sites 4, 5E, and 6. Considering the dense foliage and inaccessability of most waterfowl habitat, it is probable that more waterfowl used this area than were observed.

Raptors

Red-Tailed Hawks were observed year-round. Three individuals (two adults, one sub-adult) were seen on the Junction City study area at least twice during the year. One sub-adult was observed with a garter snake.

Accipiter investigations were hindered by limited visibility, dense underbrush, and erasure of sign by high tides and rain. Three Sharp-Shinned Hawks were observed: one at Site 1 and two at Site 5. Cooper's Hawks were seen five times: twice at sites 5 and 9, and once in the area of sites 7 and 8. Four songbird kills, possibly attributable to accipiters, were found: two on site 1, one each on sites 9 and 2.

One American Kestrel was seen hunting over site 9 in July. One Rough-Legged Hawk was seen in October north of Elliot Slough across from site 7.

Owls

Two sets of owl data were collected. Between 3 June and 4 July 1980, nine hours (three samples) were spent sampling owls

at all Junction City sites and on 3.5 km of Elliot Slough. One Barn Owl and one Screech Owl were heard north of the slough (in mature mixed-forested swamp). Three Screech Owls were heard on site 9.

From 19 February - 30 April 1981, owls were sampled twice on all sites (except site 1), and twice along the old Central Park road within a mature mixed-forested swamp. In the Junction City area, one Great Horned Owl was heard within a mature mixed-forested swamp.

One Pygmy Owl was heard on site 1, and a Great Horned Owl was seen perched in a snag on site 5.

Screech Owls and Pygmy Owls were residents in mature-mixed forested swamp. Six Screech Owls and six Pygmy Owls responded to taped calls played from 5 different stations along the old Central Park road transect. That is 3.2 owls of each species per km of transect. The maximum distance estimated for hearing either species was 300 meters. If the detection distance was 300 meters, there were 4.2 owls of each species per square km. It is difficult to estimate distances to owls in dense, forested swamp where detection distances may be 200 meters or less.

Ruffed Grouse

During April drumming Ruffed Grouse were heard only in the mature mixed-forested swamp of site 1. The maximum density observed was on 14 April. Three drumming males were heard from

four stations within the forested swamp. That calculates as 2.1 ha per grouse or 0.5 grouse per ha for that habitat. Brewer (1980) reported 9.0, 5.0 and 9.3 ha per Ruffed Grouse in Washington on the Olympic Peninsula, 1977-79. Though based on a small sample size, my observations indicate dense Ruffed Grouse populations in mature forested swamps. Considering the almost complete lack of hunting pressure, this is very possible. One Ruffed Grouse was observed on site 2, once in June and several times during fall and winter. In June, one drumming Ruffed Grouse was heard once on site 4.

No crowing Ring-Necked Pheasants were detected during grouse sampling. Crowing roosters were heard sporadically, during May and June 1980, on sites 5B and 9. Three hens were seen once at site 5B in June. The intermittant observations indicate pheasants may have only been visitors to the study area.

One California Quail was seen, during fall, west of site 9. No other quail were observed during the study.

Herons

Four species of herons used the area. Great Blue Herons hunted year-round in sloughs and marshes on sites 2, 4, 5, 5B and 9. Northern Green Herons were summer residents, observed feeding on sites 2, 4, 5, and 5B. A pair of American Bitterns nested on

site 5. American Bitterns were seen hunting in marshes on sites 5, 5B, and 9. One Black-Crowned Night Heron was heard once at site 5 in July.

Rails

Two pairs of Virginia Rails nested on site 5 and one pair nested at site 6. Virginia Rails were year-round residents. After nesting season, they were observed on sites 5, 5B, 6, 7, and 8. One pair of Soras nested on site 5. They were summer residents only. Considering how difficult rails are to find, it is probable that many more used marshes within the study area.

Biomass

Qualitative comparisons of bird numbers to habitat types ignore the concept of biomass. Many relatively heavy birds use wetland types about equally (raptors, woodpeckers, pigeons, jays and crows). However, most large wetland birds (waterfowl, herons, fish-eating waterbirds) depend on marshes and sloughs for survival (Robbins et al. 1966, Belrose 1976, Peterson 1980). **Marshes and sloughs on these sites probably support a higher biomass of birds than shrub swamp or wooded swamp.**

Impacts

Almost the entire proposed fill area is classified as wetlands (Nelson, Kolipinski and Lynn [illegible]). The area is appropriately classified as critical habitat for wildlife (ACOE

1975). Direct impacts on avian populations, by dredge disposal at sites 16, 17 or 18, are obvious. Any area filled, and subsequently industrialized, will destroy forever wetlands critical to survival of birds. Decreases in bird populations should roughly equal densities observed in different habitat types. Losses will depend on the amount and types of habitat filled.

Impacts during dredge disposal would be minimized by filling between the times most birds nest and when they begin establishing nesting territories (September - F bruary). Disturbance during this time would give birds an opportunity to attempt establishing territories elsewhere.

Indirect impacts are more difficult to predict. If disposal sites are industrialized, some impacts to remaining wetlands will occur due to pollution and noise. If better access to swamps and marshes occurs, increased hunting pressure will occur. Impacts, due to encroachment of civilization, would be minimized by eradicating roads into remaining wetlands.

CHEHALIS RIVER

A total of 46 water-related bird species were observed using the Chehalis River, Blue Slough, and Elliot Slough (Table 19). The highest diversity was observed during the late summer and fall migration period (September-December 1980). The highest numbers were seen during the winter months when western grebes and waterfowl were most abundant. Numbers of birds in the area peaked daily at high tides when fish-eating birds were pushed upstream from the harbor into the river, and when mallards could swim into marshes bordering the river.

Fish-eating Waterbirds

Loons, grebes, and cormorants were regularly observed, in the late fall to mid-spring (Table 20). Smith and Mudd (1976) also reported large numbers of Western grebes arrived in November and remained through April. These birds preferred to stay on the river, not on sloughs (Tables 21, 22, 23, Fig. 9).

Great blue herons feed in the area year-round with numbers peaking in summer (Smith and Mudd 1976). The high density of herons on Elliot Slough is explained by its proximity to the heron rookery at Lake Aberdeen.

Table 19. Numbers of species observed seasonally on Chehalis River and sloughs, September 1980 - April 1981.

Location	Number of Species			Total
	Fall[a]	Winter[b]	Spring[c]	
Chehalis River	27	24	20	37
Blue Slough	13	9	8	20
Elliot Slough	14	7	12	23
Total	34	25	25	46

[a] n(number of censuses) = 10

[b] n = 6

[c] n = 2.

Table 20. Maximum number of water-related birds seen in one day on Chehalis River and sloughs, September 1980 - April 1981.

Species	Month							
	S[a]	O[a]	N[a]	D[c]	J[a]	F[b]	M[b]	A[c]
Fish-eating waterbirds								
Common loon			1		3	1		1
Red-throated loon					2			
Arctic loon						1		1
Western grebe	9	5	33	68	28	42	56	150
Red-necked grebe						2	1	
Horned grebe			1					
Double-crested Cormorant	1	5	9	1	2	1		1
Pelagic cormorant			1					
Waterfowl								
Trumpeter swan					4			
unidentified ducks		11		4	140		31	
Mallard	28	25	57	96	154	55	22	12
American wigeon	8							1
Pintail			1					
American green-winged teal		2	5				12	26
Blue-winged teal		1		1				
Wood duck	29	22	15					7
Northern shoveler	4							
Canvasback			3					
Scaup spp.					110	47	1	12
Greater scaup			3		43	50	36	3
Bufflehead			9	10	17	6	6	
Surf scoter		1		4	1			
White-winged scoter		1			4	8	6	
Oldsquaw		1						
Common merganser			6	6	9	9	3	6
Red-breasted merganser			4		1		3	
Hooded merganser								2

Table 20 Continued.

Species	Month							
	S[a]	O[a]	N[a]	D[c]	J[a]	F[b]	M[b]	A[c]
Herons								
Great blue heron	13	10	7	5	1	1	3	4
Northern green heron	1	1						
Kingfishers								
Belted kingfisher	2	3	1	1	1	1	2	2
Shorebirds								
Spotted sandpiper	6	7	3	1	2	2	8	6
Killdeer	16	13				1		
Common snipe				5				
Fish-eating raptors								
Bald eagle			1		1		1	
Osprey							1	
Other								
American coot					4	1		
Total species	11	14	18	10	17	14	14	14

[a] n(number of censuses) = 3

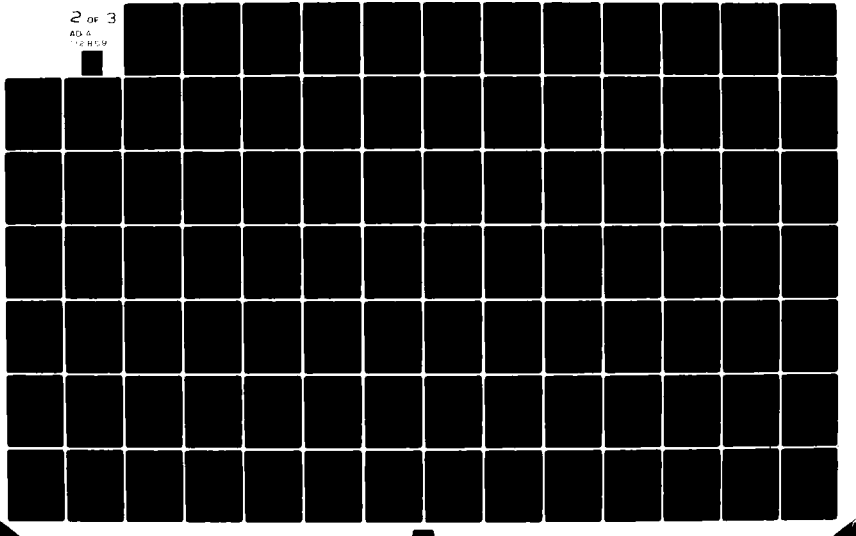
[b] n = 2

[c] n = 1.

AD-A112 859 WASHINGTON STATE DEPT OF GAME ABERDEEN F/G 13/2
GRAYS HARBOR AND CHEHALIS RIVER IMPROVEMENTS TO NAVIGATION ENVI--ETC(U)
JAN 82 S A KALINOWSKI, R C MARTIN, L D COOPER DACW67-80-C-0091

UNCLASSIFIED NL

2 OF 3
AD A
112 859



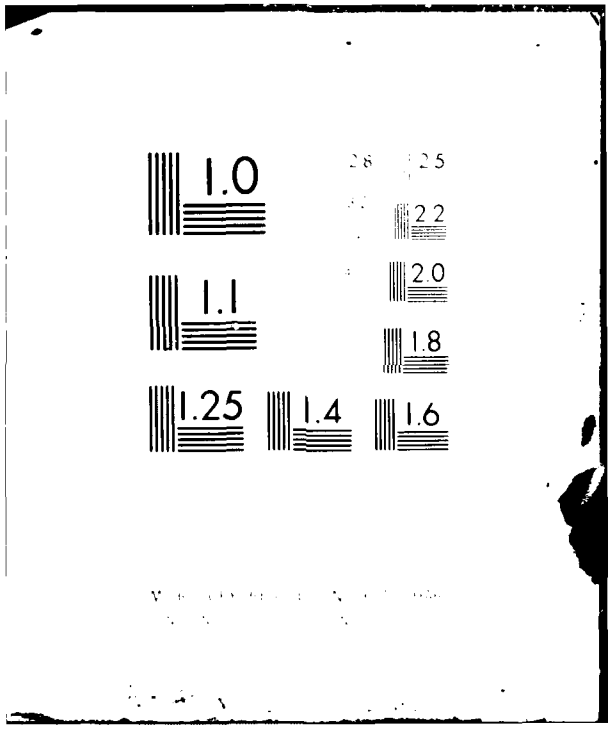

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2

Table 21. Birds per kms censused on Chehalis River, September 1980 - April 1981.

Species	Month							
	S	O	N	D	J	F	M	A
Fish-eating waterbirds								
Common loon			0.03		0.09	0.04		0.09
Red-throated loon					0.06			
Arctic loon								0.09
Western grebe	0.24	0.25	1.12	6.00	2.09	3.23	4.56	13.27
Red-necked grebe						0.09	0.04	
Horned grebe			0.03					
Double-crested cormorant	0.02	0.11	0.59		0.03	0.04		0.09
Great blue heron	0.50	0.44	0.37	0.44	0.03	0.04	0.04	0.09
Belted kingfisher	0.04	0.14	0.03		0.03	0.04		
Bald eagle			0.03		0.03		0.04	
Waterfowl								
unidentified ducks				0.35	4.13			
Mallard	0.39	0.92	2.75	8.49	8.47	3.32	1.77	0.27
American wigeon	0.17							
American green-winged teal		0.05	0.06				0.04	1.77
Blue-winged teal		0.02		0.09				
Northern shoveler	0.09							
Scaup spp.					0.03	0.57		
Greater scaup			0.08		1.27	0.44	0.04	0.27
Bufflehead			0.25	0.88	0.77	0.31	0.49	
Surf scoter				0.35	0.03			
White-winged scoter		0.05			0.15	0.62	0.40	
Oldsquaw		0.02						
Common merganser			0.08	0.18	0.41	0.53	0.22	0.44
Red-breasted merganser			0.03		0.03		0.18	

Table 21 Continued.

Species	Month							
	S	O	N	D	J	F	M	A
Shorebirds								
Spotted sandpiper	0.17	0.05	0.03			0.04		
Killdeer	0.55	0.44				0.04		0.09
Common snipe				0.44				
Other								
American coot					0.12			

Table 22. Birds per kms censused on Blue Slough, September 1980 - April 1981.

Species	Month							
	S	O	N	D	J	F	M	A
Fish-eating waterbirds								
Red-throated loon					0.14			
Western grebe				0.49	0.50	0.17	0.09	
Double-crested cormorant			0.24		0.14			
Great blue heron	0.41	0.41		0.24	0.14	0.09	0.26	
Northern green heron	0.16	0.08						
Belted kingfisher	0.16	0.24	0.08					
Bald eagle					0.07			
Waterfowl								
Trumpeter swan					0.29			
unidentified ducks		0.89						
Mallard	2.44	4.80	0.33	2.93	1.93	3.19	0.09	0.86
American wigeon								0.17
American green-winged teal			0.41					0.69
Blue-winged teal		0.08						
Wood duck	3.90	3.82	2.28					0.34
Canvasback			0.24					
Scaup spp.					15.14	4.05	0.34	1.38
Greater scaup					1.29	4.31	3.79	
Surf scoter		0.08						
Shorebirds								
Spotted sandpiper		0.08		0.24	0.14			
Killdeer	0.49							

Table 23. Birds per kms censused on Elliot Slough, September 1980 - April 1981.

Species	Month							
	S	O	N	D	J	F	M	A
Fish-eating waterbirds								
Western grebe						0.55	0.37	
Double-crested cormorant	0.19							
Pelagic cormorant			0.10					
Great blue heron	0.37	0.45	0.31	0.95	0.32	0.37	0.28	0.56
Belted kingfisher		0.07					0.19	0.37
Waterfowl								
unidentified ducks								0.19
mallard			0.72	0.95	0.32	2.41	3.15	0.19
American green-winged teal							1.30	
Blue-winged teal		0.15						
Pintail			0.10					
Wood duck								0.56
Greater scaup							1.39	
Bufflehead							0.19	
Common merganser			0.62	2.86	0.32	0.37	0.09	0.19
Red-breasted merganser			0.41					
Shorebirds								
Spotted sandpiper	2.04	0.91	0.72	0.48	0.16	0.55	1.48	0.93

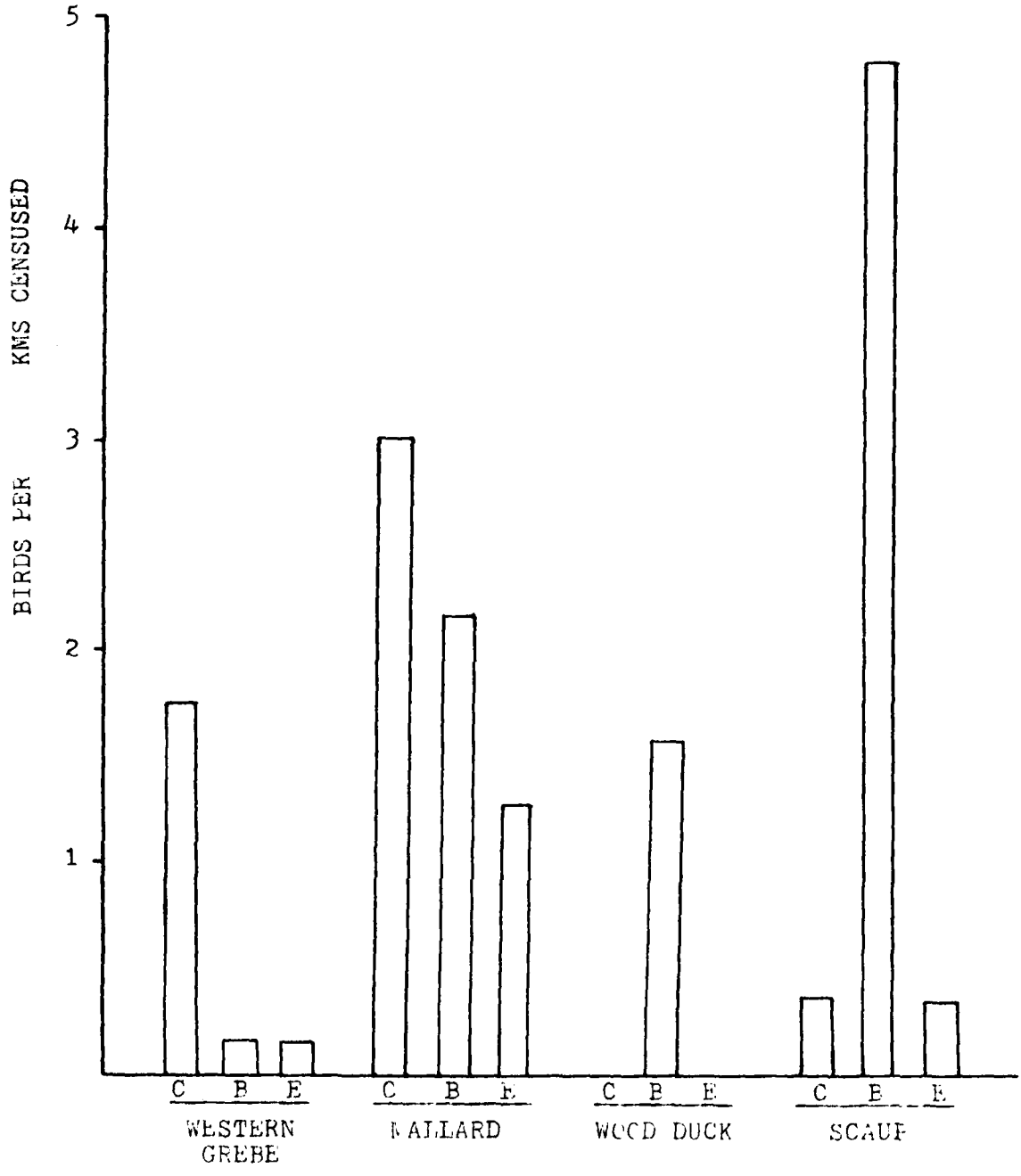


Fig. 9. Comparisons of selected species on Chehalis River (C), Blue Slough (B), and Elliot Slough (E), Sept. 1980 - April 1981.

Waterfowl

Eighteen species of waterfowl were observed on censuses (Tables 22, 23, 24). The highest diversity occurred during fall migration. Highest numbers of waterfowl were observed in winter as scaup and mallards arrived. Mallards, wood ducks, blue-winged teal and cinnamon teal were observed nesting in areas adjacent to the river and sloughs.

Mallards use the area primarily for wintering and nesting. The decreased numbers observed in April (< 1 duck/km) is attributed to their nesting in the dense foliage. The preferred feeding habitat of mallards on the Chehalis River and sloughs was the marshes bordering the river. Sixty-five percent (580) of the mallards were seen feeding in those areas. Greatest use was during tides high enough to permit mallards to swim into the marshes. Blue Slough, 23% of the total distance censused, accounted for 20% (180) of all mallard observations.

Blue Slough was the most unique area censused. Wood ducks were observed exclusively in this area. Eighty-one percent (378) of the total scaup observed wintered on Blue Slough. Every scaup identified to species was a greater scaup. Four trumpeter swans wintered on this slough. Interviews with local sportsmen indicate four to six swans wintered there last year, and possibly for the past several years.

Small numbers of scoters and mergansers were regularly observed feeding, mostly in the river. They were primarily seen

during winter and spring migrations. Observations of identical numbers of birds, seen at the same location many times, indicate white-winged scoters, common mergansers and greater scaup were winter residents of freshwater portions of the river. Other diving waterfowl moved in and out of the system as the tides fluctuated.

Shorebirds

Spotted sandpipers were the only shorebird regularly observed. These year-round residents were seen mostly on Elliot Slough. Killdeer and common snipe were observed only in migrating flocks. However, they were year-round residents in adjacent wetlands. Considering feeding habits of killdeer and snipe they probably fed on or near the banks of the river and sloughs in larger numbers than were observed.

Gulls and Terns

Large numbers of gulls (200-2500) were consistently seen between the Roderick Timber Company dock and Highway 101 bridge. They use the area almost entirely as a resting stop between estuary roosts and the Aberdeen city dump feeding grounds. Herring gulls and glaucous-winged gulls comprised the majority of wintering gulls. Western gulls began arriving in March. Smaller numbers of California gulls and ring-billed gulls were seen during summer.

Caspian terns hunt in the census area from April through August. They were observed feeding, primarily on the river, as far upstream as Higgins Island.

Raptors

I observed adult bald eagles three times between November 1980 and March 1981. Eagles were observed between Higgins Island and halfway up Blue Slough. E. Cummins[1] (personal communication) reports a nesting pair of bald eagles in the Blue Slough area. Interviews with fishermen indicate, the Chehalis River from Cosmopolis launching ramp to Higgins Island, is a year-round hunting area for adult and juvenile eagles. As many as four bald eagles were seen feeding at one time.

One osprey was seen hunting on Preachers Slough on 11 March 1981. Red-tailed hawks were consistently seen perching by open marshes adjacent to the river. One Cooper's hawk was observed hunting over Sand Island, **North Bay.**

Impacts

Direct impacts of dredging activity, on waterfowl and bald eagles in the Chehalis River system, should be minimal. Areas of highest use are upstream of proposed dredging activity. Most waterfowl are found at marshes on the river, and on upper reaches

[1]Present address: Washington Dept. of Game, Aberdeen, Wa. 98520

of sloughs. The Higgins Island marsh and upper Blue Slough supported the majority of all waterfowl. These areas are 7 kms upstream from the Cosmopolis Reach. The closest observed bald eagle activity was 5 kms upstream.

Fish-eating waterbirds commonly use the Cosmopolis Reach. Dredging during summer or fall would minimize direct impacts on these species as highest use is during winter and spring.

For birds upstream of dredging activity, indirect impacts caused by resuspended sediments, pesticides, and heavy metals would be kept to a minimum by dredging only during ebb tides. This would result in **resuspended particulates flowing into the harbor.**

SALT MARSH ESTABLISHMENT

In conjunction with a baseline assessment of avian use of the proposed salt marsh establishment site (M), bird use was studied at a salt marsh control site (MC), and between Newskah and Stafford Creeks on the south shore inner harbor (Fig. 1). Fifty-four species were seen feeding, hunting, or resting on these areas. Species and numbers observed at sites M and MC are in Table 24.

Fish-eating Waterbirds

Western grebes were the most common diving bird feeding in intertidal areas. Site MC received much higher use than site M. Impacts to grebes would be minimal, because most use of the area was in the south channel. Great blue herons regularly hunted the intertidal areas. Most were seen from August to October. Besides species listed, common loons, red-necked grebes, horned grebes, and pelagic cormorants are assumed to use sites M and MC during high tides, since small numbers were seen in the vicinity.

Waterfowl

Dabbling ducks fed year-round on the tideflats and salt marshes. A comparison of waterfowl use between sites is in Figure 10. Dabbling ducks were 2.4 times more abundant at site MC than at site M. Smith and Mudd (1976) also observed lower use along the south shore, inner harbor, as one progresses easterly. They reported 30 times more dabbling ducks at the mouth of O'Leary Creek than at the mouth of Newskah Creek.

Table 24. Total birds observed on sites M and MC on Grays Harbor, June 1980 - May 1981.

Species	Summer[a]		Fall[b]		Winter[c]		Spring[d]		Total	
	M	MC	M	MC	M	MC	M	MC	M	MC
Fish-eating waterbirds										
Red-throated loon					1				1	
Western grebe			24	67	18	34	6	29	48	130
Double-crested cormorant	4	4	6	13	1		1	2	12	19
Great blue heron	19	12	23	20	2		9	8	53	40
Belted kingfisher	1	1	1	4			1	1	3	6
Waterfowl										
Canada goose			1						1	
Mallard	88	8	17	170	25	8	16	21	146	207
Pintail	106	2	3	205	8	11		124	117	342
American wigeon	3		2	166	22	4	32	4	59	174
American green-winged teal	36			49	4		5	113	45	162
Cinnamon teal								2		2
Canvasback			10	5	93	23	6	11	109	38
Scaup spp.				1		14	23		23	15
Common goldeneye					5				5	
Bufflehead						4	2		2	4
Surf scoter			2		10		10		22	
White-winged scoter						11				11
Red-breasted merganser			4	8	4	1	9	11	16	20
Raptors										
Marsh hawk	1	1	1					1	2	2
Red-tailed hawk			2	2	1	1		1	3	4
Swainson's hawk	2								2	
Bald eagle				1	2				2	1
Peregrine falcon		1								1
Merlin		1								1
Cooper's hawk								1		1

Table 24 Continued.

Species	Summer[a] M	Summer[a] MC	Fall[b] M	Fall[b] MC	Winter[c] M	Winter[c] MC	Spring[d] M	Spring[d] MC	Total M	Total MC
Gulls and terns										
Herring gull					2	2			2	2
Western gull							8	1	8	1
Bonaparte's gull	125	63	21	229			99	68	245	360
Caspian tern	7	3					20	6	27	9
Shorebirds										
Whimbrel	4								4	
Spotted sandpiper				1						
Greater yellowlegs							1	2	1	2
Lesser yellowlegs	2								2	
Dowitcher spp.								700		700
Short-billed dowitcher			5				55	860	60	860
Semi-palmated plover							2		2	
Dunlin			48	2430			290	510	338	2940
Sanderling			2						2	
Least sandpiper	1	129							1	129
Western sandpiper	112	2120	25	266			5550	10,520	5687	12,906
Passerines										
Crow spp.	20	4		1	1	8	13		34	13
Common crow	2	1				2		3	2	6
Northwestern crow	1				2	7		4	3	11
Total species	17	13	18	18	16	13	21	23	35	32

[a] n(number of counts) = 14

[b] n = 15

[c] n = 14

[d] n = 19.

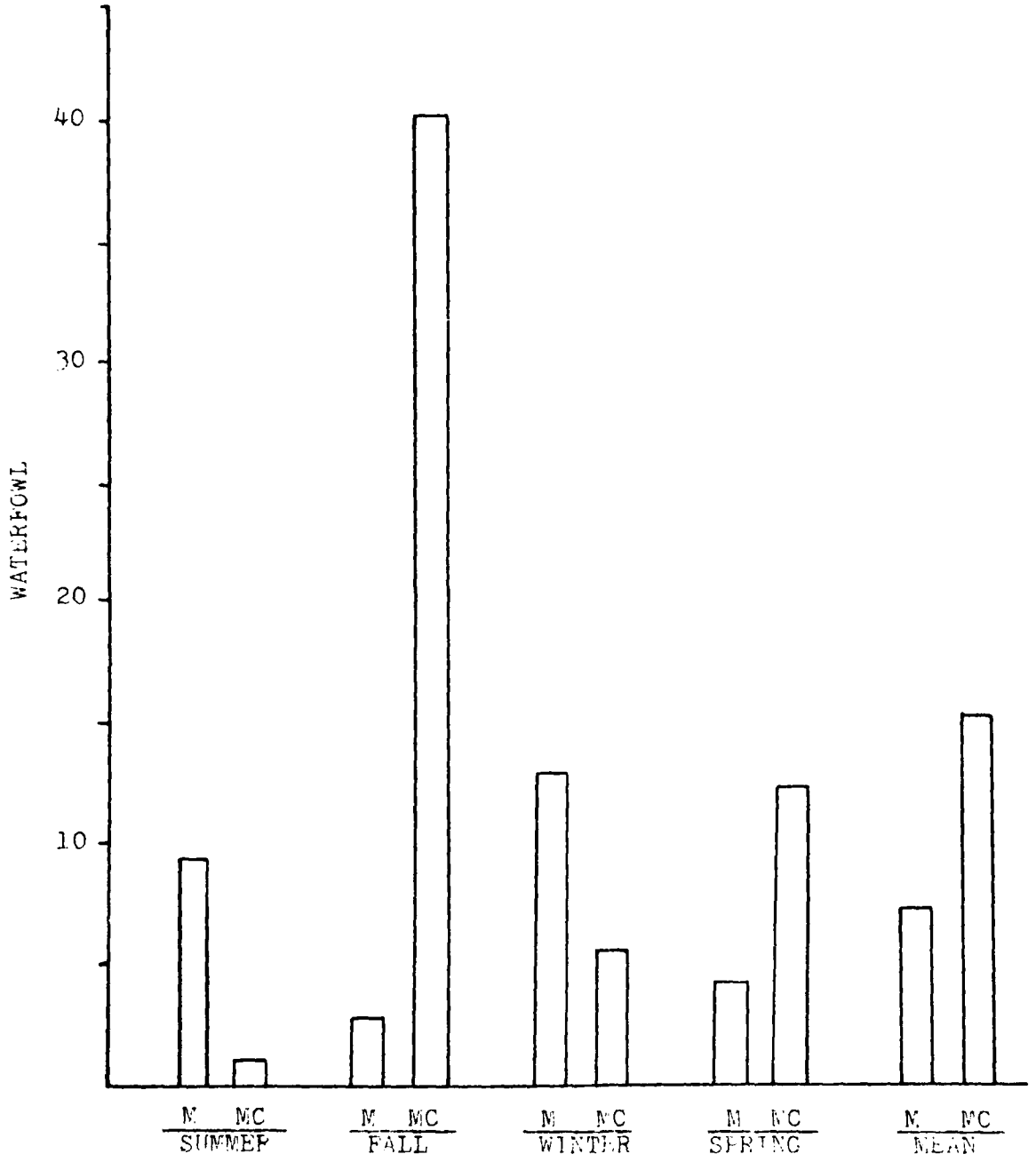


Figure 10. Mean number of waterfowl observed by season at sites M and MC on Grays Harbor, June 1980 - May 1981.

Low use of sites M and MC, compared to the rest of Grays Harbor, was observed during aerial censuses (Table 25). The south shore, inner harbor comprises 10.1% of the Grays Harbor shoreline. It supported only 2.3% of the harbor's dabbling duck population. Most dabbling ducks used the north and south bays. Sites M and MC do not lie within a preferred area.

The lower use at site M, compared to MC, is probably a function of four factors: first, it is farther from preferred areas (eg. North Bay, Bowerman Basin) than site MC; second, M has less salt marsh; third, M is closer to industrial activity and associated noise; fourth, M is within walking distance of hunters (eg. teenagers) living in south Aberdeen. Newskah Creek to site M area received heavy hunting pressure during waterfowl and band-tailed pigeon seasons.

Most dabbling duck use occurred during fall and spring (74%). Fall observations accounted for 49% of all use. Summer and winter use was low. Most "summer" dabblers were seen during August and September. Pintails comprised 37% of all dabblers seen at sites M and MC, while mallards accounted for 28% of all observations. American wigeon and American green-winged teal represented 19% and 17% respectively.

Diving waterfowl comprised 19% of all observed waterfowl. Canvasbacks were the most common diver. A flock of 90 - 120 wintered in the vicinity of site M. They were observed feeding on eelgrass. In addition to species listed, common mergansers

were observed in the vicinity. **All scaup identified to species were greater scaup, except for 2 which were lesser scaup.**

Overall impact of the salt marsh establishment should be positive. Food habits studies have shown the value of salt marshes to dabbling ducks. As shown by Smith and Mudd (1976), seeds, especially Carex lyngbyei and Triglochin maritimum, supplement their diets during high tides.

All dabblers observed feeding on salt marshes swam into the marshes during high tides, feeding as they swam. Therefore, the highest value for dabblers would be obtained by constructing the edge of the salt marsh, bordering the water, at the lowest elevation C. lyngbyei and T. maritimum can tolerate. This appears to be 2.1 meters above MLLW. This low elevation at the shore edge would result in the maximum time the salt marsh would be available to feeding ducks during high tide.

Raptors

Nine species of diurnal raptors were seen hunting over tideflats and salt marshes in the vicinity of sites M and MC. Redtailed hawks and marsh hawks were frequently seen hunting over salt marshes along the south shore inner harbor. Cooper's hawks and sharp-shinned hawks are common residents of forests surrounding the harbor. Both were frequently seen hunting over salt marshes.

Bald eagles were observed 11 times at or between sites M and MC (includes aerial sightings; Fig. 11). Five adults and one juvenile were seen perched in a favored snag at the east edge of site M. Eight sightings were during winter. During salt marsh construction, this 30 meter high snag should be left undisturbed.

One juvenile peregrine falcon (25 August 1980) and one merlin were seen hunting over site MC. One juvenile peregrine was observed six times, 11 - 18 November 1980, at the marsh east of the Newskah Creek south (Fig. 11).

American kestrels were infrequently seen, during spring and summer, over the large marsh by south shore dredge disposal site A. One osprey was seen perched directly across the south channel from site MC.

Owls were not studied on the harbor proper. Owls residing in bordering forests (screech owl, pygmy owl, great horned owl, barn owl) may hunt over salt marshes at night.

Gulls and Terns

Large gulls rarely used sites M and MC. Bonaparte's gulls (98% juveniles) commonly probed the tideflats for food during summer months. Many adults and juveniles were seen during early fall. Ring-billed gulls and California gulls were observed incidentally in the vicinity. Caspian terns were regularly observed during their nesting season, hunting over intertidal areas of sites M and MC during high tides. More caspian terns were

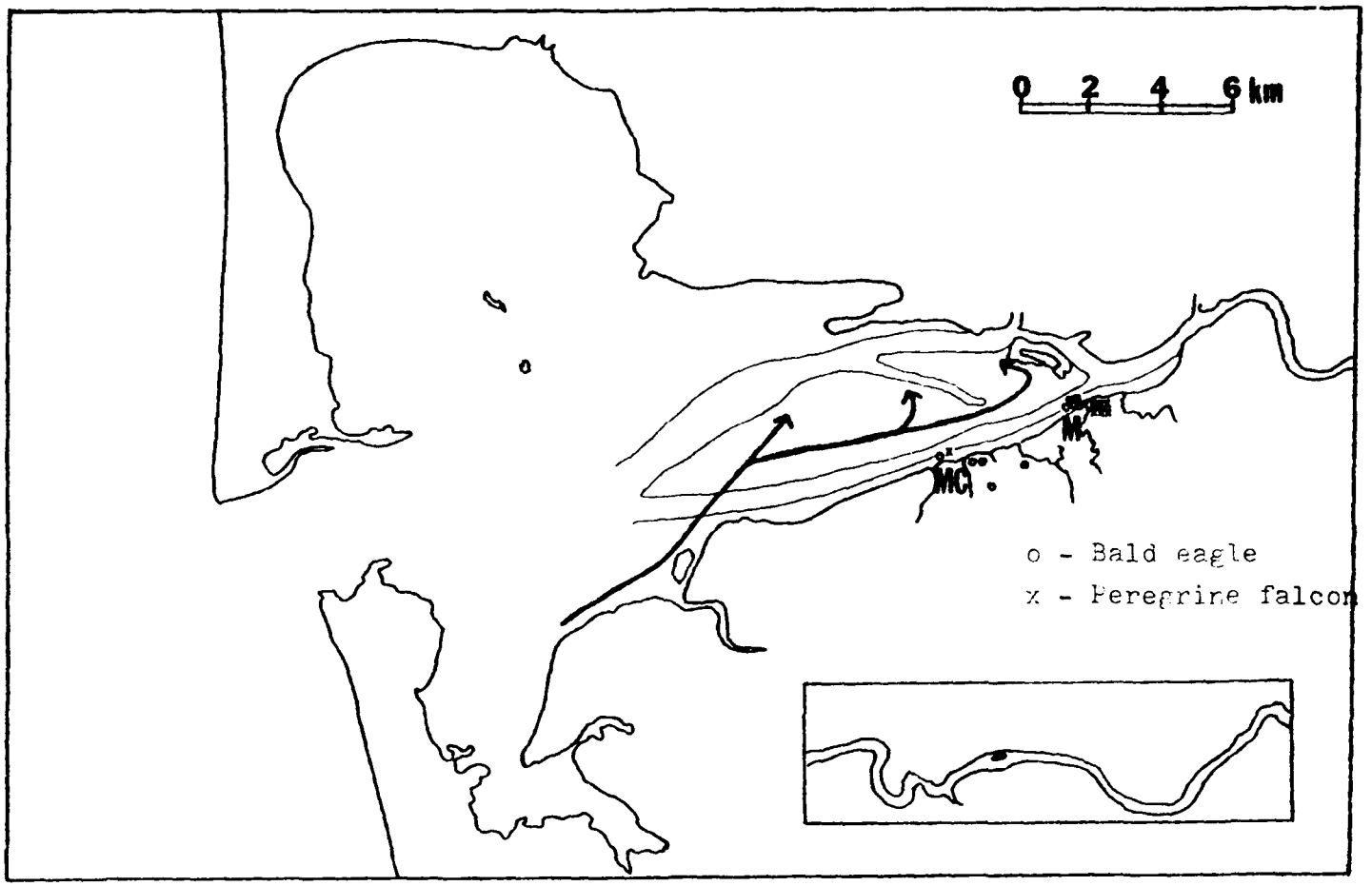


Figure 11. Bald eagle and peregrine falcon observations at salt marsh establishment and control sites on Crays Harbor, June 1980 - May 1981. Also, shorebird migrating and feeding routes (→) observed on inner Grays Harbor during winter and spring.

seen at site M because it is closer to their favorite resting site on the inner harbor (Rennie Island).

Shorebirds

Sites M and MC were used by shorebirds mostly during migrations. The short spring migration accounted for 78% of all shorebirds seen. Numbers were highest at low tides when the most tideflat was exposed. Site MC received nearly three times more use than site M (Fig. 12). Smith and Mudd (1976) observed similiar lower use of the south shore inner harbor as one progresses easterly. They reported nine times higher shorebird use at their O'Leary Creek tideflat site than at their Newskah Creek tideflat site.

Low use was observed on the south shore, inner harbor, compared to the rest of Grays Harbor (Table 25). This area comprises 10.1% of Grays Harbor shoreline, but supported only 4.1% of all shorebirds censused during flights. Even this low percentage is exaggerated, because 69% of the birds reported for south shore, inner harbor were on south shore dredge disposal site A. The shoreline accounted for only 1.3% of all shorebirds censused. One must remember that aerial censuses were conducted during high tides. At low tides, heavy use occurred between Newskah Creek and Stafford Creek during spring migration. Peak use at site M by shorebirds occurred on 27 April 1981 when 12,500 shorebirds per 40.5 ha was observed. That same day, I estimated **that**

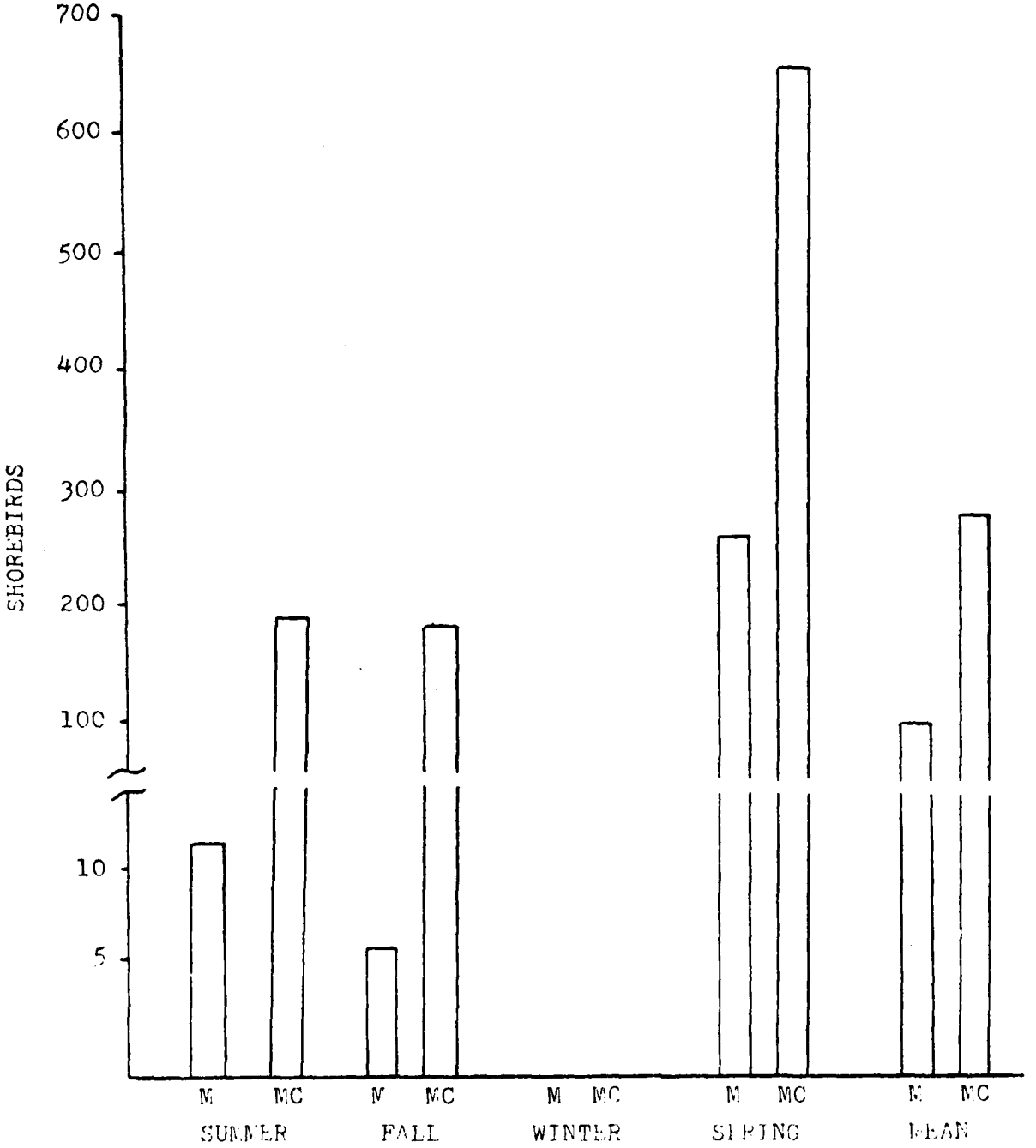


Figure 12. Mean shorebird numbers observed by season at sites M and MC on Grays Harbor, June 1980 - May 1981.

Table 25. Percent of total observations from aerial censuses of selected species seen on 14 areas of Grays Harbor, November 1980 - May 1981.

Species	Area[a] 1	2	3	4	5	6	7	8	9	10	11	12	14	15	Total
Mallard	1.1	0.4	49.8	1.1	1.1	1.0		28.8	4.6	5.1	0.1	2.8	3.3	0.8	100
Pintail	8.7	3.1	34.3	1.7	1.2			6.2	1.4	1.8		1.7	40.0*		100
American wigeon	6.8		68.9	0.2	0.1	0.6		11.5	3.2	0.1	0.1	2.5	5.1*	0.8	100
American green-winged teal	46.7[b]	0.7	10.2		0.6			30.6	0.5	2.3	0.4	2.2	6.1		100
Canvasback	16.7	6.2	61.0					1.6	0.3		1.0	6.7	5.3	1.2	100
Black brant		0.1	32.6	17.7		1.9	9.6	13.1	9.0	0.1	15.1	0.1	0.9		100
Shorebirds	25.9	4.6	20.0	12.0	1.2		10.3	6.7	9.2	0.3	1.3	4.1	4.3	0.1	100

[a] See Table 6 for area names.

[b] Biased by one large flock observed 25 November 1980.

71,000 shorebirds were in the area bounded by Newskah Creek, Stafford Creek and the south channel. At that time, at least 844,000 shorebirds were in Grays Harbor (Table 26).

Pathways followed by migrating and feeding shorebirds during winter and spring (Fig. 11), may explain the low use observed most of the year at sites M and MC as the main flight paths do not go over site M.

Two types of flocks flew the western route. One type, high-flying migratory flocks were seen on this route, but never observed feeding by us. The other type of flock [illegible]sed this route was composed of birds which had been feed[illegible] mudflats at Johns River.

Pathways used by birds alternated [illegible]een feeding and flying short distances along the routes. Feeding shorebirds preferred the middle channel tideflats over the south shore, inner harbor. When incoming tides covered tideflats, most flocks flew in the directions shown (Fig. 11).

These migratory and feeding behaviors probably explain the low use observed at sites M and MC. Both sites lie outside of migratory pathways. Neither site lies within a preferred feeding area. The higher use observed at site MC is probably explained by its being nearer commonly used routes.

Nine species of shorebirds were observed at site M, 6 at MC. Western sandpipers, dunlin, and dowitchers (most were short-billed)

Table 26. Numbers of migratory shorebirds censused on Grays Harbor, spring 1981.

Date	Estimated[a] Number	Calculated[b] Number
17 April	85,000	83,000
24 April	379,000	844,000
5 May	105,000	209,000
13 May	49,000	85,000
TOTAL:	618,000	1,321,000

[a] Number of birds estimated during census flights.

[b] Estimated number times correction factor derived from shorebird counts from aerial photos.

comprised 99.4% of all observations. Feeding occurred almost entirely on tideflats.

Least sandpipers are the only species of shorebirds in Grays Harbor that show a preference for salt marshes (Robbins et al., 1966). This would be the only species of shorebird that may benefit from construction of the proposed salt marsh. A total of 60 were seen feeding in site MC salt marsh during a high tide in August. Only one was seen at site M all year.

Dunlin and western sandpipers comprised 92.5% of all shorebird observations. Both species feed in salt marshes during high tides (Smail 1970, Smith and Mudd 1976). This food habits study indicated some of these species feed in salt marsh during high tides. At low tides, 125 km^2 of tideflat are available

to shorebirds (Gatto 1978). Only 15.33 km^2 of salt marsh (Gatto 1978) are available during high tides. Therefore, using dredge disposal to change 8-12 ha of tideflat into salt marsh should not have a negative impact on shorebirds.

The most visible shorebird use of the proposed salt marsh will occur after dredged material disposal and before establishment of salt marsh plants. Shorebirds were observed feeding year-round, on all dredged material disposal areas around the harbor. These areas were used when tides covered harbor tideflats. I observed flocks of 5,000-17,000 western sandpipers, dunlin, dowitchers and yellowlegs feeding on dredged material disposal site A during spring migration.

Terrestrial Birds

Small numbers of crows (common crow, northwestern crow) regularly fed on tideflats at sites M and MC. Barn swallows and violet-green swallows occurred at both sites. Cliff swallows were seen only at site M. Savannah sparrows and song sparrows were common on the salt marshes. Table 27 presents species and nesting densities observed in the mature mixed-forested swamp adjacent to site M (Site 10). The dense forest should minimize stress imposed by dredge disposal activities on these species.

It is difficult to predict the effects of establishing a salt marsh in Grays Harbor on birds. Several studies have assessed the development of marshes on dredged

Table 27. Species and mean nesting densities (birds/ha) observed at site 10, May 1980 - May 1981. T is total individuals observed. An X indicates non-nesting species observed incidentally, rarely, or during nesting season.

Species	Spring			Nesting[a]			Fall			Winter		
	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD	T	$\bar{x}$	SD
Raptors												
Red-tailed hawk		X			X			X			X	
Swainson's hawk					X							
Sharp-shinned hawk											X	
Gallinaceous birds												
Ruffed grouse					X							
Pigeons												
Band-tailed pigeon					X			X				
Goatsuckers												
Common nighthawk					X							
Hummingbirds												
Rufous hummingbird		X		4	1.5	2.8						
Woodpeckers												
Common flicker		X			X			X			X	
Downy woodpecker					X							
Passerines												
Barn swallow		X			X			X				
Cliff swallow					X			X				
Violet-green swallow		X			X							
Tree swallow		X										
Rough-winged swallow					X			X				
Steller's jay					X			X				
Common crow		X			X			X			X	
Black-capped chickadee		X		5	1.2	1.7		X			X	
Chestnut-backed chickadee		X			X			X			X	
Bushtit		X			X			X			X	
Winter wren		X						X			X	

Table 27 Continued.

Species	Spring T	Spring $\bar{x}$	Spring SD	Nesting[a] T	Nesting[a] $\bar{x}$	Nesting[a] SD	Fall T	Fall $\bar{x}$	Fall SD	Winter T	Winter $\bar{x}$	Winter SD
American robin		X			X						X	
Varied thrush		X			X						X	
Swainson's thrush				78	5.2	4.1		X				
Golden-crowned kinglet		X		17	8.7	13.3		X			X	
Ruby-crowned kinglet		X		4	1.1	2.9		X			X	
Cedar waxwing					X			X				
Orange-crowned warbler				4	0.9	1.9						
Yellow warbler					X							
Yellow-rumped warbler								X				
Townsend's warbler								X			X	
Black-throated gray warbler								X				
Common yellowthroat								X				
Wilson's warbler		X		16	3.3	4.2		X				
Brown-headed cowbird								X				
Western tanager								X				
Purple finch		X			X						X	
House finch								X				
Pine siskin		X									X	
American goldfinch								X				
Dark-eyed junco		X									X	
White-crowned sparrow								X				
Golden-crowned sparrow								X				
Fox sparrow								X				
Song sparrow		X		20	4.2	3.5		X			X	
Total species[c]		20			28			29			17	

[a] n(nesting stations sampled) = 8.

[b] See note d, Table 3.

[c] Total species, entire study = 44.

material and/or resulting effects on birds. Smith (1978) discussed specific aspects of marsh development. Vincent (1978) concluded salt marsh establishment on Rennie Island, Grays Harbor was economically infeasible. Buckley (1978), Parnell et al. (1978), and Schreiber and Schreiber (1978) studied bird use of dredged material islands on the Atlantic coast. They found that birds used dredged material islands readily, and that the species using islands changed as plant succession occurred on the islands.

AERIAL CENSUS

Ten flights over Grays Harbor, between November 1980 and May 1981, provided data for wintering populations and numbers of spring migrants using the estuary. Subdivision of the harbor into areas (Fig. 9, Table 6) allowed an analysis of area preference or avoidance by the major species.

Fish-eating waterbirds

This group (except great blue herons) was incompletely counted since they disperse over the harbor (Table 28). Loons, grebes and cormorants are much more abundant than this data indicates (Smith and Mudd 1976). Large numbers of Western grebes were observed in April when flocks gathered for migration.

Table 28. Numbers of birds of all species seen during Grays Harbor censuses, November [illegible] - May 1981.

	1980		1981							
	25 Nov	9 Dec	8 Jan	29 Jan	27 Feb	2 Apr	17 Apr	24 Apr	5 May	13 May
Fish-eating waterbirds										
Common loon	2	1								4
Western grebe			32	42	1	50	197	316	6	
Cormorant spp.	31	31	6	14		28	190	401	774	43
Great blue heron	9	24	9	65	6	37	12	15	55	55
American coot		45	130	32	97	30				
Waterfowl										
Canada goose	10		20			3		850		
Snow goose			2							
Black brant	208	610	95	405	361	698	1,210	840	99	15
Mallard	1,500	3,727	234	1,518	432	738	799	788	113	35
Pintail	5,834	780	112	401	15	385	183	2,317	96	76
Gadwall				4				26	6	4
American wigeon	2,413	6,915	1,255	1,342	486	320	875	2,123	296	28
Northern shoveler		27		17	7	6	16	10	2	40
Cinnamon teal									16	
American green-winged teal	7,615	4,465	1,339	600	28	560	201	1,665	194	45
Redhead	44	300				80				
Canvasback	302	322	240	499	338	218		6		
Ring-necked duck	4			12				12		
Scaup spp.	28	92	175	310	140	399		274	135	98
Goldeneye spp.	11	53	3	115	45	24	27	22		6
Bufflehead	122	49	224	145	81	139	14		5	2
Harlequin duck				2						
Scoter spp.	15	164	196	247	182	308	28	210	15	162
Ruddy duck	10	8	6	25	2	23		21	5	
Merganser spp.	39		6	20	11	54	28	74	54	124
Shorebirds										
Long-billed curlew										4
Whimbrel	40						160	60	108	7
Medium shorebirds				147	43	356	4,413	19,922	4,970	5,344
Small shorebirds	11,400	35,690	3,900	13,690	15,760	22,695	84,800	379,450	104,730	49,160
Gulls and terns										
Gull spp.							5,042	6,940	13,000	9,570
Caspian tern							539	1,103	4,428	3,782
Small terns										103
Raptors										
Bald eagle	1	4	5	6	4	2	4	?	1	3
Marsh hawk	1	2	3	3	1	?	2		1	1
Red-tailed hawk		4	4	6	1		1			
Rough-legged hawk		?	2	1						
Buteo spp.				1					2	

Double-crested cormorants were seen primarily in April and May at their nesting colony on Goose Island.

Waterfowl

Only the end of fall migration was censused. Smith and Mudd (1976) censused 45,000 ducks on Grays Harbor during a mid-November flight. A significant difference between Smith's fall census and our's is the numbers of American green-winged teal seen. Smith and Mudd (1976) reported green-wings in hundreds. Our peak count was 7600.

Winter censuses (8 January - 27 February 1981) indicate between 1800 and 5600 ducks used the harbor (Table 29). The most common wintering ducks were American wigeon, mallard, and American green-winged teal. Smith and Mudd (1976) reported canvasback, scaup spp., and bufflehead as the most common ducks during January and February 1975. Wintering canvasback numbers on this study were less than half the 1100 reported by Smith and Mudd (1976) on a February 1975 census. Numbers of wintering black brant were equal to maximum numbers seen from a boat in one day by Smith and Mudd (1976).

The total number of waterfowl observed by us (9240 on 24 April 1981) during spring migration was nearly twice that seen by Smith and Mudd (1976).

The 5 most common migrating waterfowl in spring were American wigeon, pintails, black brant, American green-winged teal and mallards.

Table 29. **Aerial counts of waterfowl, shorebirds,** gulls and terns on Grays Harbor, November 1980 - May 1981.

Date	Ducks	Geese	Shorebirds	Gulls & Terns
1980				
25 November	18,000	210	11,400	[a]
9 December	16,500	610	35,700	[a]
1981				
8 January	4,400	120	3,900	[a]
29 January	5,600	410	13,800	[a]
27 February	1,800	360	15,700	[a]
2 April	3,200	700	23,100	[a]
17 April	2,200	1,210	89,400	5,600
24 April	7,500	1,690	399,400	8,000
5 May	930	100	109,500	17,400
13 May	820	110	54,500	13,500

[a] Not censused

Shorebirds

The first five censuses in this study were considered within the wintering period for shorebirds on Grays Harbor (Smith and Mudd 1976). Between 4000 and 36,000 shorebirds were observed on those counts ($\bar{X}$ = 16,000)(Table 29). Species composition in Grays Harbor **was** described by Smith and Mudd (1976).

Four flights (17 April - 13 May 1981) were conducted during spring migration. Shorebird numbers peaked at 400,000 on 24 April. The number of shorebirds, in flocks of 1000 - 80,000 birds, are difficult to estimate. Most observers consistently underestimate numbers of birds in large flocks. The error tends to increase geometrically as flock sizes increase (J. Smith, pers. comm.[1]). Most shorebirds censused in spring were in flocks larger than 4000. Preliminary comparisons of actual numbers (from enlarged photographs) to estimates, indicate a conversion factor greater than 2.0 for flocks of more than 4000 birds. For flocks of 1000 - 4000, I consider Smith and Mudds' (1976) conversion of 1.5 low, but usable. Based on preliminary data and personal observations, spring shorebird counts were corrected by multiplying the estimated flock size by the conversion factor sizes (Table 26).

---

[1] Present address: Washington Dept. of Game, Aberdeen, WA 98520.

Since many flocks were larger than 4000 (up to 80,000), I still consider these conversion factors conservative.

Gulls and Terns

Gulls and terns were censused during April and May when large numbers began arriving. Our peak count of 17,400 was similar to Smith and Mudds' (1976) peak count (15,000) in June 1975. Nesting gulls (western gull, glaucous-winged gull, and hybrids) were seen mainly on Goose, Sand, and Whitcomb Islands. Nesting caspian terns were seen exclusively on Sand Island. This colony relocated from Whitcomb Island in 1975-76 (Jack Smith, pers. comm.[1]).

Raptors

Birds of prey were regularly seen perching on snags, pilings, and islands on the harbor. Numbers peaked in December and January. Bald eagles were seen on every flight (Fig. 13). The adult to sub-adult ratio was 29:2. Smith and Mudd (1976) saw only four bald eagles on their entire study (July 1974 - December 1975). This information indicates bald eagle use of Grays Harbor has increased substantally over the past 5 to 6 years.

SITE PREFERENCE

Table 25 summarizes total aerial observations of selected

---

[1] Present address: Washington Dept. of Game, Aberdeen, WA 98520.

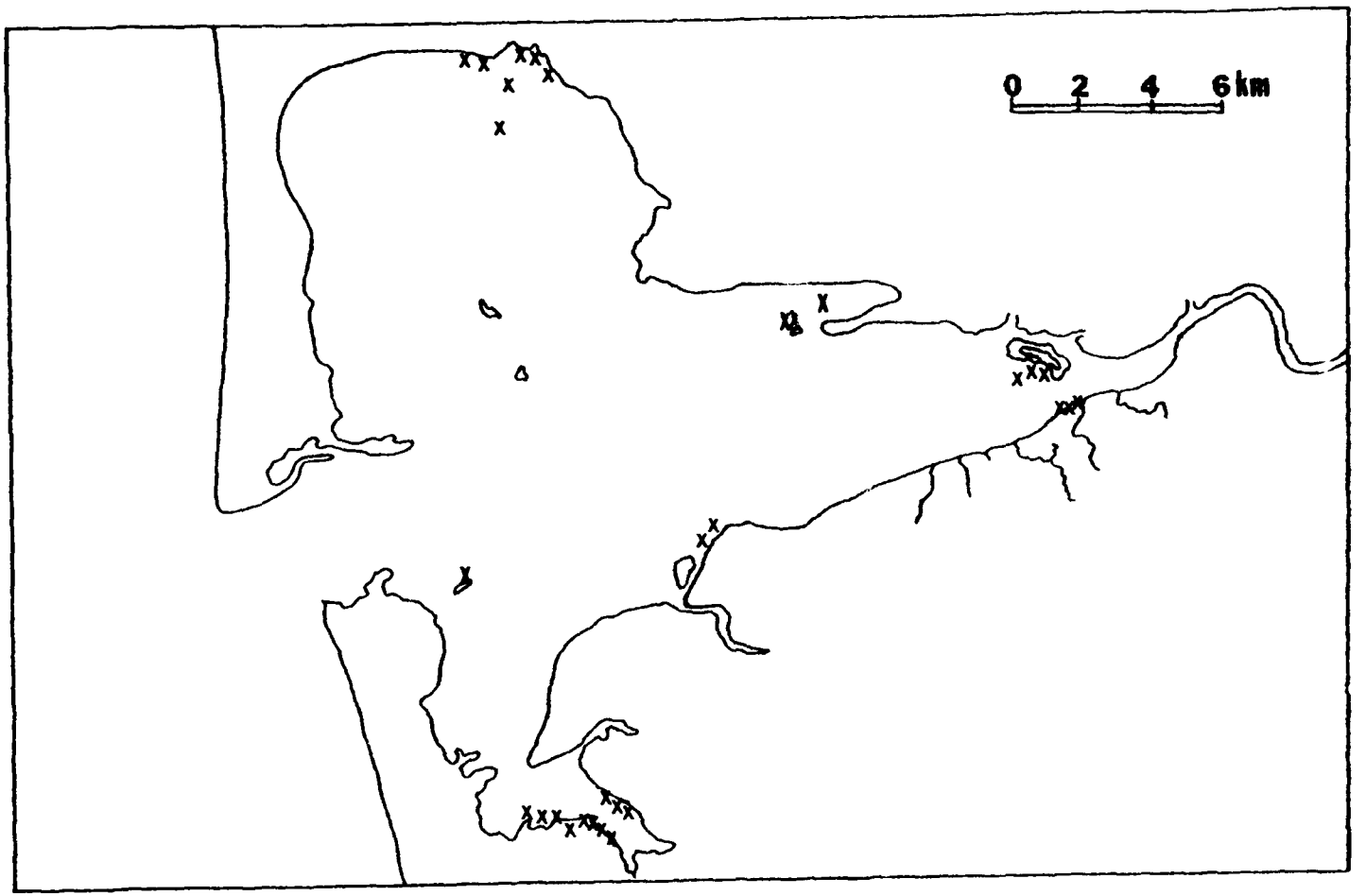


Figure 13. Observations of bald eagles during ten aerial censuses on Grays Harbor, November 1980 - May 1981.

species by area. This basic preference/avoidance analysis compares number of individuals of a species seen at each area with the percent of the total Grays Harbor shoreline represented by each area. It is intended as a gross analysis of the most important areas to the most common species that use the harbor.

If populations were randomly distributed, percent of birds at each area would equal the percent of total available habitat represented by each area. Therefore, if more or less birds are seen than the percent of total shoreline given for each site, a preference or avoidance of the area is assumed. Many factors can influence the areas chosen by birds. Habitat type, prey availability, psychological factors, and nearness to migratory routes are a few.

One bias of this analysis is using shoreline distance as the criterion for determining area size. Avian use of an estuarine habitat, especially by shorebirds, is usually a function of exposed tideflat. Since areas exposed vary with tide height, a consistent area represented by each area cannot be determined. Also, since our censuses were conducted at high tides, data are biased towards areas preferred at high tides.

Waterfowl

Seventy-nine percent (8280) of mallards censused were in the north and south bays. Pintails and American wigeon consistently preferred the north bay. One migratory flock of 4000 pintails

and 700 wigeon skewed the data for Rennie Island. One migratory flock of 7100 American green-winged teal was seen in Bowerman Basin. Fifty-three percent (53%) of all other green-wings censused were in the south bay, south of the highway 105 bridge. Canvasbacks preferred the north bay and Bowerman Basin. Twelve percent (12%) wintered in the area of Rennie Island, and sites M and MC. Black brant were usually seen in rafts or flying in the vicinity of Sand Island and Whitcomb flats areas.

Shorebirds

Most shorebirds were observed at sites with tideflats still exposed at high tide. Preferred sites were dredge disposal areas (Bowerman basin, Little Moon Island, site A), harbor islands (Sand Island, Whitcomb flats, Rennie Island), and Ocosta beach with its high, sandy tideflat. Although this accounts for only 3% of the shoreline of Grays Harbor, 26% of all shorebirds were seen there.

FOOD HABITS

Shorebirds

A total of 128 shorebirds of four species were collected from Grays Harbor tideflats between 15 November 1980 and 4 March 1981. Specimens were very hard to obtain because wintering populations were small and widely dispersed on the harbor.

Birds were collected between 1.3 and 2.9 meters (above M.L.L.W.) to sample a diversity of prey items. Intertidal invertebrate prey populations are known to vary with elevation (Smith, Albright, & Rammer 1976, P. Bouthillette, pers. comm.[1]). Invertebrate populations are also known to vary seasonally (Smith, Albright, & Rammer 1976, R. Albright, pers. comm.[2]). Since 90% of the specimens were collected in January 1980, the data are safely interpreted only as representing winter prey items.

Dunlin

Ninety-nine dunlin were collected; 46 had identifiable contents in their esophagi. For the usable specimens, 25 were collected at the mouth of John's River across the river from

---

[1] Present address: Washington Dept. of Game, Aberdeen, WA 98520.

[2] Present address: Fisheries Dept., University of Washington, Seattle, WA.

Markham Island, 16 at Ocosta ("bottle beach"), three east of site MC, and two west of the Humptulips River mouth.

Cumulative data are presented in Table 30. Amphipods (mostly Corophium spp.), comprised 44.5% of the total food items. Other major food items were tanaids (31.1%), insects, larvae, and egg cases (9.5%), and annelids (6.0%). Four teeth and two bones of a Microtus sp., dissected from a dunlin at Ocosta, were probably consumed as grit since no meat or hair was found. Smith and Mudd (1976) also found amphipods important to Dunlin in Grays Harbor. Couch (1966) reported amphipods as the most important food item to Dunlin wintering in western Washington.

Tables 31 and 32 present the data from John's River and Ocosta separately. Dunlin at John's River fed on Corophium spp. and tanaids. Corophium spp., insect larvae, and egg cases were the primary food items at Ocosta.

Western sandpiper

Nineteen western sandpipers were collected; 11 contained identifiable contents. Ten were shot at Ocosta, and 1 at site MC. Prey items are in Table 33. The data must be viewed carefully since one bird contained 127 of 148 prey items collected from the entire group. Oligochaetes comprised half the food items. Salt marsh seeds represented 29.1%. Amphipods, mostly Eogammarus confervicolus, were 12.2% of the total. This kind of qualitative analysis is biased towards small food items (e.g. oligochaetes,

Table 30. Food items of dunlin in Grays Harbor, November 1980 - March 1981.

Number of specimens (esophagi) = 99 Number with identifiable contents = 46 INVERTEBRATE FAUNA	Occurrence in 46 esophagi	Total number in 46 esophagi	Percent occurrence in 46 esophagi	Percent occurrence in 116 food items
Phylum Annelida				
Class Polychaeta				
unknown polychaetes	3	3	6.5	2.6
Subclass Errantia				
Family Goniodidae				
unknown goniadids	2	2	4.3	1.7
Subclass Sedentaria				
unknown sedentariates	1	1	2.2	0.9
Family Spionidae				
Polydora ligni	1	1	2.2	0.9
Phylum Nematoda				
unknown nematodes	2	2	4.3	1.7
Phylum Mollusca				
Class Pelecypoda				
Order Filibranchia				
Family Mytellidae				
unknown mytellids	1	1	2.2	0.9
Phylum Arthropoda				
Class Crustacea				
Order Copepoda				
unknown copepods	1	1	2.2	0.9
Order Cumacea				
Leucon sp.	2	2	4.3	1.7
Order Tanaidacea				
unknown tanaids	1	1	2.2	0.9
Leptochelia dubia	6	35	13.0	30.2
Order Amphipoda				
Family Gammaridea				
Corophium spp.	23	46	50.0	39.7
Eogammarus confervicolus	6	6	13.0	5.2
Class Insecta				
unknown insects	2	2	4.3	1.7
unknown insect larvae	5	6	10.8	5.2
egg cases	2	2	4.3	1.7
Order Collembola				
unknown collembola	1	1	2.2	0.9
TOTAL				96.8

Table 30 Continued.

Number of specimens (esophagi) = 99 Number with identifiable contents = 46	Occurrence in 46 esophagi	Total number in 46 esophagi	Percent occurrence in 46 esophagi	Percent occurrence in 116 food items
VERTEBRATE FAUNA				
Microtus sp. (teeth and bones)	1	1	2.2	0.9
TOTAL				0.9
FLORA				
seeds				
Zostera noltii	1	1	2.2	0.9
Carex lyngbyei	1	2	2.2	1.7
TOTAL				2.6

Table 31. Food items of dunlin at John's River tideflat, Grays Harbor, January - February 1981.

Number of specimens (esophagi) = 41 Number with identifiable contents = 25 INVERTEBRATE FAUNA	Occurrence in 25 esophagi	Total number in 25 esophagi	Percent occurrence in 82 food items
Phylum Annelida			
Class Polychaeta			
unknown polychaetes	2	2	2.4
Subclass Errantia			
Family Goniadidae			
unknown goniadids	2	2	2.4
Subclass Sedentaria			
unknown sedentariates	1	1	1.2
Family Spionidae			
Polydora ligni	1	1	1.2
Phylum Arthropoda			
Class Crustacea			
Order Copepoda			
unknown copepods	1	1	1.2
Order Cumacea			
Leucon sp.	3	3	3.7
Order Tanaidacea			
Leptochelia dubia	4	33	40.2
Order Amphipoda			
Family Gammaridea			
Corophium sp.	18	33	40.2
Eogammarus confervicolus	2	2	2.4
Order Collembola			
unknown collembola	1	1	1.2
FLORA			
seeds			
Carex lyngbyei	1	2	2.4

Table 32. Food items of dunlin at Ocosta tideflat, Grays Harbor, January - March 1971.

Number of specimens (oesophagi) = 43 Number with identifiable contents = 16 INVERTEBRATE FAUNA	Occurrence in 16 oesophagi	Total number in 16 oesophagi	Percent occurrence in 29 food items
Phylum Annelida			
Class Polychaeta			
unknown polychaetes	1	1	3.4
Phylum Nematoda	1	1	3.4
Phylum Mollusca			
Class Pelecypoda			
Order Filibranchia			
Family Mytellidae			
unknown mytellids	1	1	3.4
Phylum Arthropoda			
Class Crustacea			
Order Tanaidacea			
unknown tanaids	1	1	3.4
Leptochelia dubia	2	2	6.9
Order Amphipoda			
Family Gammaridea			
Corophium sp.	3	9	31.0
Rogammarus confervicolus	1	1	3.4
Class Insecta			
unknown insects	2	2	6.9
unknown insect larvae	3	6	10.3
egg cases	2	3	10.3
VERTEBRATE FAUNA			
Microtus sp. (teeth and bones)	1	1	3.4
FLORA			
seeds			
Zostera noltii	1	1	3.4

Table 33. Food items of western sandpipers in Grays Harbor, December 1980 - March 1981.

Number of specimens (esophagi) = 19 Number with identifiable contents = 11 INVERTEBRATE FAUNA	Occurrence in 11 esophagi	Total number in 11 esophagi	Percent occurrence in 148 food items
Phylum Annelida			
Class Oligochaeta			
unknown oligochaetes	1	74[a]	50.0
Class Polychaeta			
unknown polychaetes	1	3[a]	2.0
Phylum Mollusca			
Class Pelecypoda			
unknown clam	1	1	0.7
Phylum Arthropoda			
Class Crustacea			
Order Tanaidacea			
unknown tanaids	1	1	0.7
Leptochelia dubia	2	6	4.1
Order Amphipoda			
Family Gammaridea			
unknown gammarids	1	1	0.7
Corophium sp.	1	3	2.0
Eogammarus confervicolus	1	12[a]	8.1
Amphithoe spp.	1	2	1.4
Class Insecta			
unknown insects	2	1	0.7
TOTAL			70.3
PISCA			
seeds			
unknown seeds	3	42[a]	[illegible]
Zostera marina	1	1	[illegible]
Triglochin maritimum	1	1	[illegible]
TOTAL			[illegible]

[a] In the esophagus of one bird. Thirty-eight of the unknown seeds were in the one bird.

seeds) with small food value.

Sanderling

Three of eight sanderling collected at Ocosta had identifiable contents (Table 34). Sanderling were observed feeding at higher elevations than other shorebirds. Many were observed feeding in salt marshes even when tideflats were exposed. Though based on a small sample, the terrestrial insect and three salt marsh seeds found in esophagi support feeding observations.

Least sandpiper

The esophagi of the two least sandpipers collected at the Salicornia salt marsh south of Westport were empty. The gizzard contents are listed on Table 35. As previously stated, gizzard analysis can be biased towards hard food items such as terrestrial insects.

Waterfowl

Sixteen waterfowl of four species were collected on Grays Harbor between 16 October 1980 and 4 March 1981. They were extremely hard to obtain because of low wintering numbers and the avoidance of the south shore, inner harbor. Total waterfowl use of the south shore, inner harbor was negligible from mid-October 1980 to February 1981. Common observations were 0-10 dabbling ducks along 6.5 kms of shoreline in the initial study area

Table 34. Food items of sanderling at Oceeta tideflat, Grays Harbor, January - February 1981.

Number of specimens (esophagi) = 8 Number with identifiable contents = 3 INVERTEBRATE FAUNA	Occurrence in 3 esophagi	Total number in 3 esophagi
Phylum Annelida		
Class Oligachaeta		
unknown oligochaetes	2	13
Phylum Arthropoda		
unknown insects	1	1
FLORA		
seeds		
unknown seeds	1	3
Zostera marina	1	1

Table 35. Food items of least sandpipers at Westport salt marsh, Grays Harbor, August 1980.

Number of specimens (gizzards) = 2 Number with identifiable contents = ? INVERTEBRATE FAUNA	Occurrence in 2 gizzards	Total number in 2 gizzards
Phylum Arthropoda		
unknown terrestrial insect adults	1	3
Class Crustacea		
Order Amphipoda		
Family Gammaridea		
unknown gammarids	1	1

(Newskah Creek to Stafford Creek). In January 1981, the sampling area was expanded to include the north and south bays of the harbor.

All ducks were shot from shore while feeding at the 2.2 - 2.9 meter elevations. Prey items taken must be considered as a function of prey available at those elevations. Dabbling ducks might feed on eelgrass or intertidal invertebrates at low tide or, they may feed on the seeds of salt marsh plants. Dabbling ducks were observed feeding in salt marshes from 1 - 4 hours during high tide, depending on elevation of the salt marsh and tide height. Almost all other feeding activity observed, occurred on the mudflats during low tide.

Pintail

Seven pintails were collected at four locations. Two were shot on 5 November 1980 while feeding on the salt marsh at the mouth of Campbell Creek. On 6 January 1981, 2 were shot, 200 meters northwest of the Grass Creek mouth, while feeding at the interface between salt marsh and tideflat. Two were collected on 8 January 1981 one km east of the Humptulips River mouth. They were also feeding at the salt marsh-tideflat edge. One was shot at site MC, on 4 March 1981, while dabbling in 30 cm of water.

Amphipods comprised 62.9% of the prey items (Corophium spp. 58.9%) (Table 36). Salt

Table 36. Food items of pintails in Grays Harbor, November 1980 - March 1981.

Number of specimens (esophagi) = 7 Number with identifiable contents = 7 INVERTEBRATE FAUNA	Occurrence in 7 esophagi	Total number in 7 esophagi	Percent occurrence in 29,777 food items
Phylum Annelida			
Class Polychaeta			
unknown polychaetes	2	20	*
Family Ampharetidae			
Hobsonia sp.	2	20	*
Phylum Nemateda			
unknown nematode	2	20	*
Phylum Mollusca			
Class Pelecypoda			
Order Eulamellibranchia			
Family Myidae			
Mya arenania	1	16	*
Family Tellinidae			
Macoma sp.	2	36	0.1
Macoma balthica	1	22	0.1
Class Gastropoda			
unknown snails	1	4	*
Phylum Arthropoda			
Class Crustacea			
Order Cumacea			
Leucon sp.	2	144	0.5
Order Tanaidacea			
Tanais sp.	4	232	0.8
Order Isopoda			
Gnorismosphaeroma oregonensis	3	48	0.2
Order Amphipoda			
Family Gammaridea			
unknown gammarids	3	53	0.2
Corophium sp.	4	17,537	88.9
Eogammarus confervicolus	6	970	3.3
Ampithoe sp.	2	179	0.6
Class Insecta			
unknown insects	1	8	*
unknown insect larvae	5	410	1.4
unknown pupa casings	2	9	*
Class Arachnida			
unknown spiders	1	4	*
TOTAL			66.3

Table 36 Continued.

Number of specimens (esophagi) = 7 Number with identifiable contents = 7	Occurrence in 7 esophagi	Total number in 7 esophagi	Percent occurrence in 29,777 food items
FLORA			
seeds			
unknown seeds	6	1,251	4.2
Zostera nolti	5	1,217	4.1
Zostera marina	5	95	0.3
Carex lyngbyei	6	3,485	11.7
Triglochin maritimum	6	3,988	13.3
vegetation			
Zostera noltii	2	a	
TOTAL			33.7

[a] Total of three leaves and less than 0.1 grams rhizomes.

* Less than 0.1%.

marsh seeds were 20.3% of [illegible] total. The 2 pintail collected at Campbell Creek were feeding almost exclusively on salt marsh seeds and insect larvae. The 2 pintail collected at Grass Creek contained mostly Corophium spp. and salt marsh seeds. The [illegible] pintails from east of the Humptulips River contained mostly Carex lyngbyei seeds and Eogammarus confervicolus. The pintail at MC was feeding on Zostera noltii, but also had 8 Corophium spp. and 5 E. confervicolus in its esophagus.

Most pintails seen feeding at tide levels other than high tide (greater than 2.4 meters M.L.L.W.) were feeding on mud covered with 0 - 8 cm of water. This behavior, supplemented by prey items found in pintails feeding this same way, indicates intertidal invertebrates were the preferred food items during this study. Connelly and Chesemore (1980) also found pintails prefered invertebrates as a food item during winter in California marshes.

Mallard

Three mallards were collected between 16 October 1980 and 27 January 1981. Total food items are in Table 37. Amphipods comprised 97.6% of the prey items found in this small sample. One mallard, shot on the salt marsh at Campbell Creek, contained one unknown seed. Another mallard, collected at site MC, was feeding on Zostera noltii and Corophium spp. A mallard shot one km east of the Humptulips River contained all other prey items, including the 106 Eogammarus confervicolus.

Table 37. Food items of mallards in Grays Harbor, October 1980 - January 1981.

Number of specimens (esophagi) = 3 Number with identifiable contents = 3 INVERTEBRATE FAUNA	Occurrence in 3 esophagi	Total number in 3 esophagi	Percent occurrence in 121 food items
Phylum Arthropoda			
Class Crustacea			
Order Tanaidacea			
Tanais sp.	1	1	0.8
Order Isopoda			
Gnorismosphaeroma oregonensis	1	1	0.8
Order Amphipoda			
Family Gammaridea			
Corophium sp.	1	6	5.0
Eogammarus confervicolus	1	106	87.6
TOTAL			94.2
FLORA			
seeds			
unknown seeds	2	6	5.0
Zostera noltii	1	1	0.8
Vegetation			
Zostera noltii	1	[a]	
TOTAL			5.8

[a] Rhizomes - less than 0.5 grams.

Mallards were commonly observed standing on the tideflat while feeding. It is possible that intertidal invertebrates were the chosen prey of these mallards.

American wigeon

Three wigeon were collected between 16 October 1980 and 15 January 1981. One wigeon, collected at the edge of site MC's salt marsh, was feeding on Zostera noltii leaves and rhizomes and Eogammarus confervicolus. Two wigeon, shot at the mouth of John's River east of Markham Island, were feeding on Zostera spp. in about 60 cm of water. One contained Z. noltii (85% of volume) and Z. marina (15% of volume). The other had only Z. noltii. Yocom and Keller (1961) reported high use of Zostera sp. by American wigeons in Humboldt Bay, California. Smith and Mudd (1976) also reported wigeons feeding on eelgrass in Grays Harbor.

During this study, most wigeon were seen feeding in eelgrass beds in 60 - 90 cm of water. However, many were observed feeding directly on the mud. It is possible that intertidal invertebrates are more important to wigeon than this small sample indicates.

American green-winged teal

Three green-wings were collected at John's River mouth. All

Table 38. Food items of American wigeon in Grays Harbor, October 1980 - January 1981.

Number of specimens (esophagi) = 3 Number with identifiable contents = 3 INVERTEBRATE FAUNA	Occurrence in 3 esophagi	Total number in 3 esophagi
Phylum Arthropoda		
Class Crustacea		
Order Amphipoda		
Family Gammaridea		
Eogammarus confervicolous	1	1
FLORA		
seeds		
unknown seeds	1	3
Zostera noltii	1	20[a]
vegetation		
Zostera noltii	3	
Zostera marina	1	

[a] One seed pod.

esophagi were empty. The green-wings observed on this study fed intertidally over deep water (20 - 100 cm), at the water's edge and while standing on the mud. They also supplemented their diets with salt marsh seeds during high tides.

PART V

MAMMALS

METHODS AND MATERIALS

POPULATION SAMPLING OF MAMMALS

Small Mammals

Small mammals were trapped during spring (May 15 - June 29), summer (July 21 - August 13), fall (October 1 - November 7), and winter (February 2 - February 28). Transects were placed on 11 sites (one per site) within each sampling period representing four different cover types.

Transects were approximately 100 meters long with a trapping station every 10 meters. Three Sherman live traps were placed in mammal runways, or in small mammal microhabitat within two meters of each trapping station. All traps were baited with a mixture of peanut butter, oatmeal and molasses (Gentry et al. 1966). Each trap was baited at the beginning of a three night trapping sequence and only rebaited if a capture was made. Traps were set on the first day of each trapping sequence and checked every morning for three consecutive days.

When an animal was captured, the species, sex, age, location (site and station), date, time, sexual activity, and occurrance of capture was recorded. If the animal had died within the trap, it was placed in a plastic bag and frozen to be sexed, aged, and keyed to species in the lab. Each individual was marked, either by ear punching or tail clipping (shrews), upon their first capture.

The Schnabel method was used to estimate population sizes for

mark-recapture data (Tanner 1978). Analysis of variance among population estimates were tested by single classification anova with equal sample sizes and by the least significant difference test (Sokal and Rohlf 1969).

An index of diversity was designed after McIntosh (1967). The index was:

$$\left(\sum_{i=1}^{s} n_i^2 \right)^{\frac{1}{2}}$$

s = number of species.
n = number of individuals per 100 trap nights.

A trap night equals one trap set for one night. Therefore, 100 trap nights equals one trap set for 100 nights, or 100 traps set for one night, or any combination in between. Trap night success was substituted for number of individuals per species to standardize units of effort between sampling dates and sites.

Big Game

Deer

Deer were sampled by spotlighting both along the river and sloughs by boat, along roads by car, and on foot. A deer drive was conducted with the help of students from Grays Harbor Community College. Circular pellet group transects were also surveyed during this project. Interviews with hunters were conducted to determine hunter success.

Bear

Black bear scent stations were established in several locations on the study area (Fig. 14). Scent stations consisted of a circle 1.8 m in diameter cleared of all vegetation (Lindzey, Thompson, and Hodges 1977). Anise and Caromon's Long Distant lure were used to lure bears into the cleared circle where tracks would be left and identification would be possible.

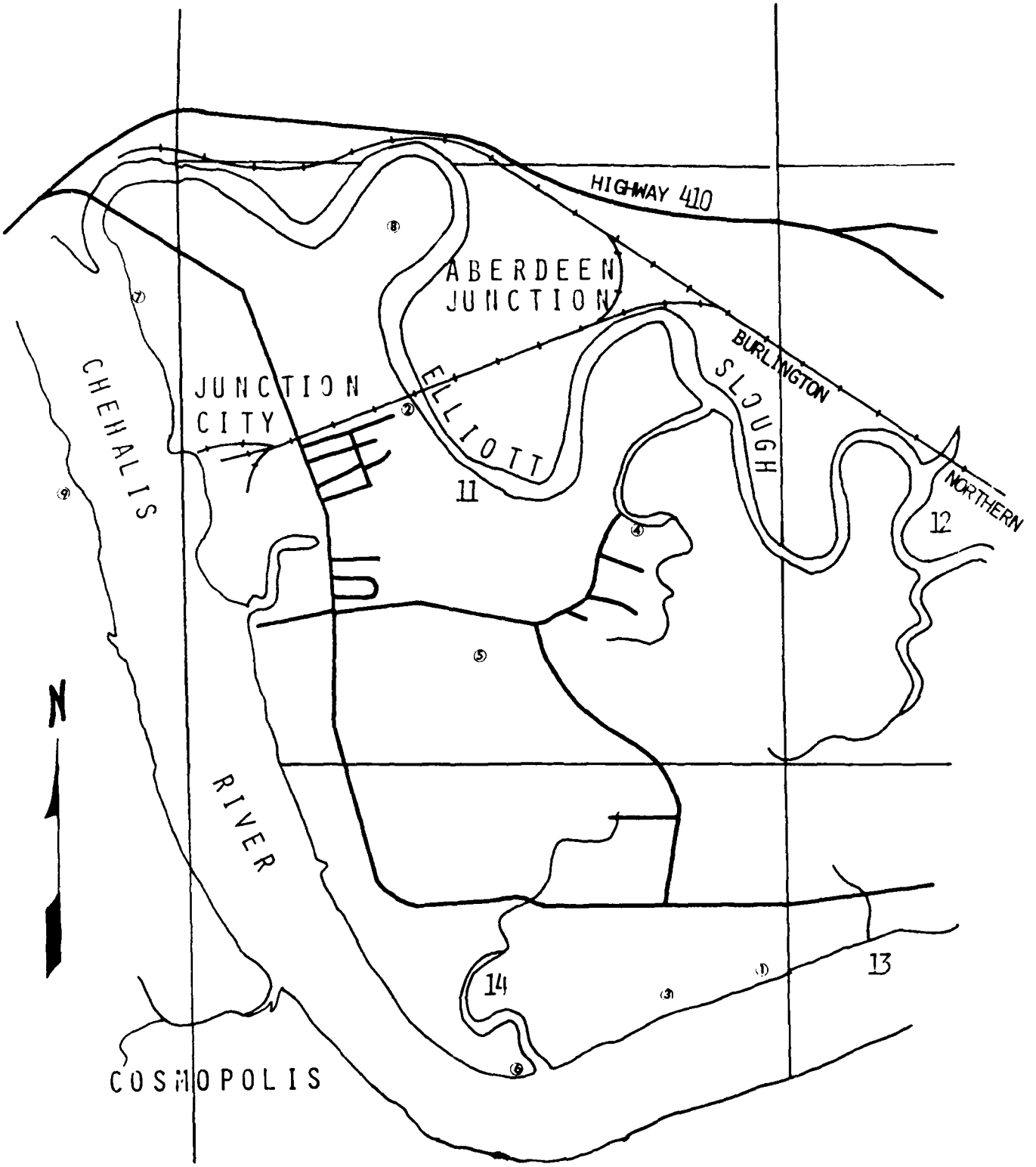


Figure 14. Location of bear and furbearer scent stations (o) near Junction City, Washington, during 1980-81.

Aquatic and Terrestrial Furbearers

Nine scent stations were built throughout the study area (Fig. 14). These stations were made by first clearing all debris and vegetation from an area 1.8 m in diameter (Lindzey, Thompson, and Hodges 1977). They suggest sifting sand and soil through a $\frac{1}{4}$" screen to produce a better substrate for track identification. This procedure was not used because most soil found in the study area was either sandy or moist and held tracks well without the addition of sifted soil. Second, a small bag of scent was suspended from a limb approximately four feet above the center of the circle. Two types of scent were used; first a mixture of ground sardines and vegetable oil (Jim Tabor, pers. communication[1]) and second, Carmon's Long Distance Lure supplied by the United States Fish and Wildlife Service.

Each scent station was checked for tracks every other day as weather permitted. Only the presence or absence of tracks was noted as it was not possible to estimate populations with this technique. Mammal tracks at each station were identified to species when possible. After all tracks were counted, the soil within the station was raked smooth.

All scent stations were placed in areas with three criteria in mind; proximity to terrestrial furbearer habitat, easy access but removed from public view and in an area with little overhead

[1] Washington Dept. of Game, Ephrata, Wa. 98823.

vegetative cover. If scent stations were placed under vegetative canopies, rain dripping from this cover would have made track identifications impossible.

Scat samples were collected throughout the study. Scats were placed in plastic bags in the field, transported back to the laboratory where they were analyzed. First, scat samples were partially dissolved using "scat solution"(Bard and Kenny, 1974). Scat solution contained; 10 parts 95% ethyl alcohol, 3 parts water, and 1 part carboxymethylcellulose (0.4% solution). One part scat and seven parts solution were combined and vigorously agitated. After approximately 24 hours, scats were placed in preservative (10% formalin solutions), and the presence of food items were recorded.

By law, at the end of each trapping year, trappers in the state of Washington are required to submit a "trapper report". Individual trappers state the number of furbearers trapped by species, and the county in which they were trapped for the previous year. Such information was useful in determining general trends and the importance of the area to furbearers.

In addition to the "trappers report", a questionnaire was sent to 85 trappers residing in Grays Harbor and Pacific counties. Seven questions were asked about the 1979-80 and 1980-81 trapping seasons (Appendix B). All trappers who reported trapping either during the present season, or during past seasons within the study area, were contacted.

Spotlight sampling was conducted both for deer and terrestrial furbearers. Spotlighting for aquatic furbearers has been tried without success (Wood, pers. communication[1]). In conjunction with spotlighting for terrestrial furbearers, a predator call (rabbit distress call) was used to draw the animals within the range of the spotlight.

A twelve volt car battery was tied to a pack and a spotlight equipped with a red lens attached to the battery. Approximately 30 minutes after dusk, a series of predator calls were emitted. Then once every five minutes for 20 minutes the area around the observer was scanned with the light. If nothing was sighted, the observer moved approximately 400 meters and started again.

Necropsys were conducted on five species; beaver, muskrat, river otter, eastern cottontail, and Townsend mole. Individuals were either trapped or found dead on the study area.

Ground surveys (systematic searches for sign as well as visual observation of animals) were conducted on all major sloughs and streams. During all times on the study area, incidental observations of all animals were recorded.

Beaver and nutria were trapped at five different scrub and shrub swamp systems. Bailey live traps and coon cat traps (a

[1] Washington Dept. of Game, Olympia, Wa.

paste made of ground beaver caster glands and oil from the oil sac of male beavers) were set on slides and runs. Trapping was restricted to tides below 3 m. to avoid drowning animals.

Traps were checked every morning at dawn to reduce the liklihood that trapped individuals would catch cold or suffer from hypothermia. Upon capturing a beaver or nutria, general condition of the animal pelt condition and size, weight, sex were recorded.

Self piercing, 9/16" ear tags numbered and stamped Washington Department of Game property, were placed in one ear of the animal. This was made easier by placing the animal (beaver and nutria) in a burlap bag, then placing one knee on each side of the animals head. A small hole was cut in the bag so that an ear could be drawn out of the bag and tagged. This method has proved effective and efficient causing little trauma to the animal (Lund, pers. communication[1]). A "capture stick" was used to hold raccoons while the tag was put into place.

Sex of beaver and nutria was determined by the presence or absence of os baculum (Osborn 1955). All other terrestrial furbearers were sexed by observation of external morphology.

---

[1] Washington Dept. of Game, Aberdeen, Wa. 98520.

RESULTS AND DISCUSSION

Small Mammals

Population estimates were made for deer mice (Table 39). Population estimates were not made for other small mammal species because of small sample sizes (Figures 15,16,17). Only three of the 11 study sites (3, 4, and 6) had sufficient data to estimate populations for all four seasons. Four sites (7, 8, M, and MC) lacked one season's estimate, one site (1) lacked two season's estimates, three sites did not have sufficient data for any population estimates (Table 39). There were no deer mice captured on site 9 during this study. Analysis of variance of the population estimates for deer mice was conducted. No significant (P=0.05) differences were found among estimates for seasons or areas.

Vagrant shrew was the only species found on all 11 study sites (Table 2). Masked shrew occurred second most frequently (10 sites), followed by deer mice and Trowbridge shrew (9 sites). Six species were present on one site only. They were: Oregon vole, measow jumping mouse, long-tailed weasel, northern flying squirrel, Douglas squirrel and black rat (Table 40). Habitats present on proposed fill sites 16, 17, and 18 is marginal for these species.

Eight different species were found on site 4 with the lowest number of species (5) being found on sites 1, M, 7, and 8 (Table 40). Breakdown by season indicate 13 different species were trapped

Table 39. Population estimates of deer mice/ha, determined by the Schnabel method with mark-recapture data, during four sampling periods on 11 study sites located within the Grays Harbor study area.

	Sites										
Season	1	2	3	4	5B	6	7	8	9	M	MC
Spring	105	X	97	210	X	133	80	35	X	-	-
Summer	X	X	40	110	X	66	X	X	X	230	83
Fall	X	X	142	165	X	150	100	40	X	280	325
Winter	50	X	141	188	X	320	280	400	X	123	165

X = sample size was too small for population estimate.

- = insufficient data for population estimate.

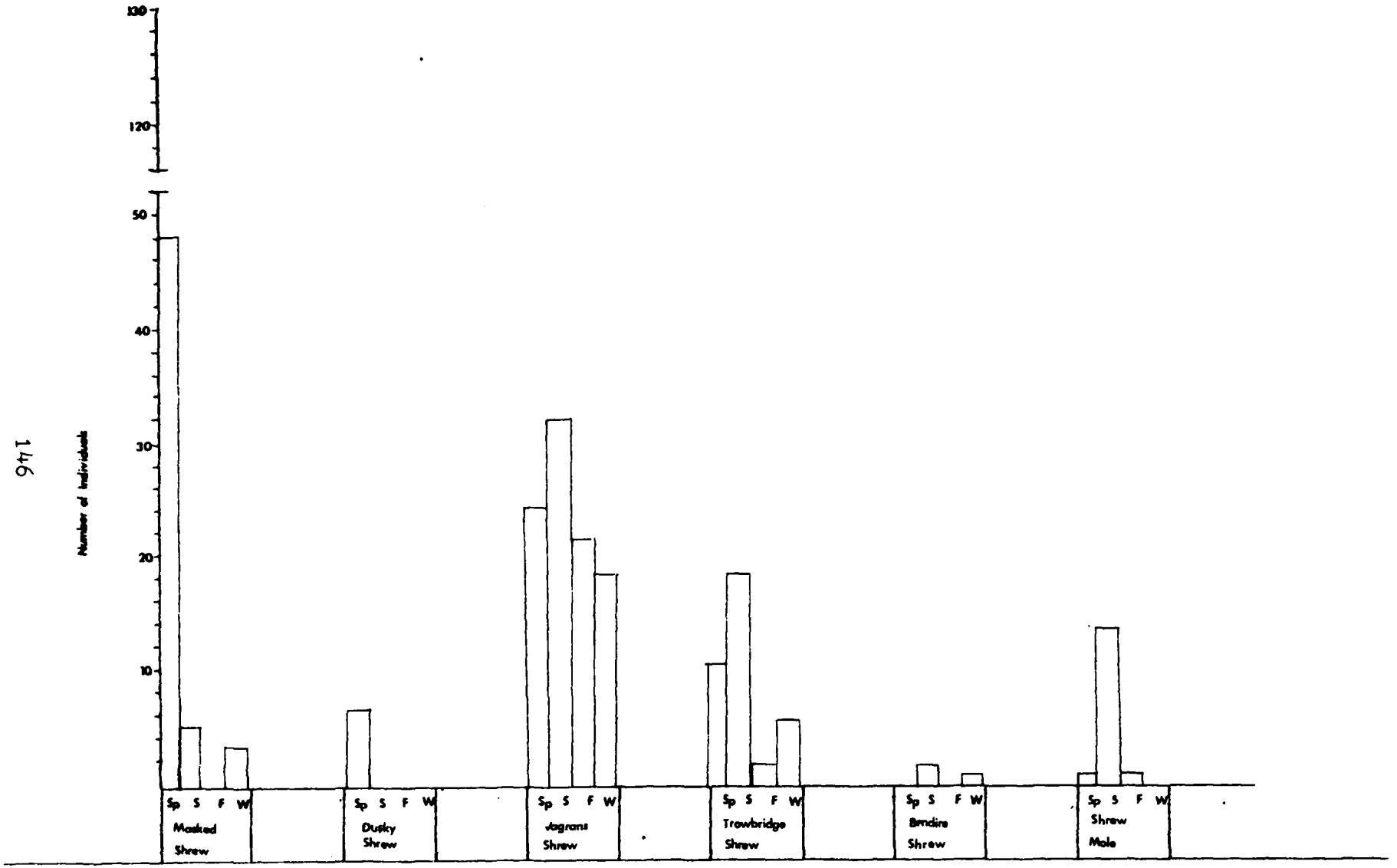


Figure 15. Numbers of shrews and moles captured on all study sites by season.

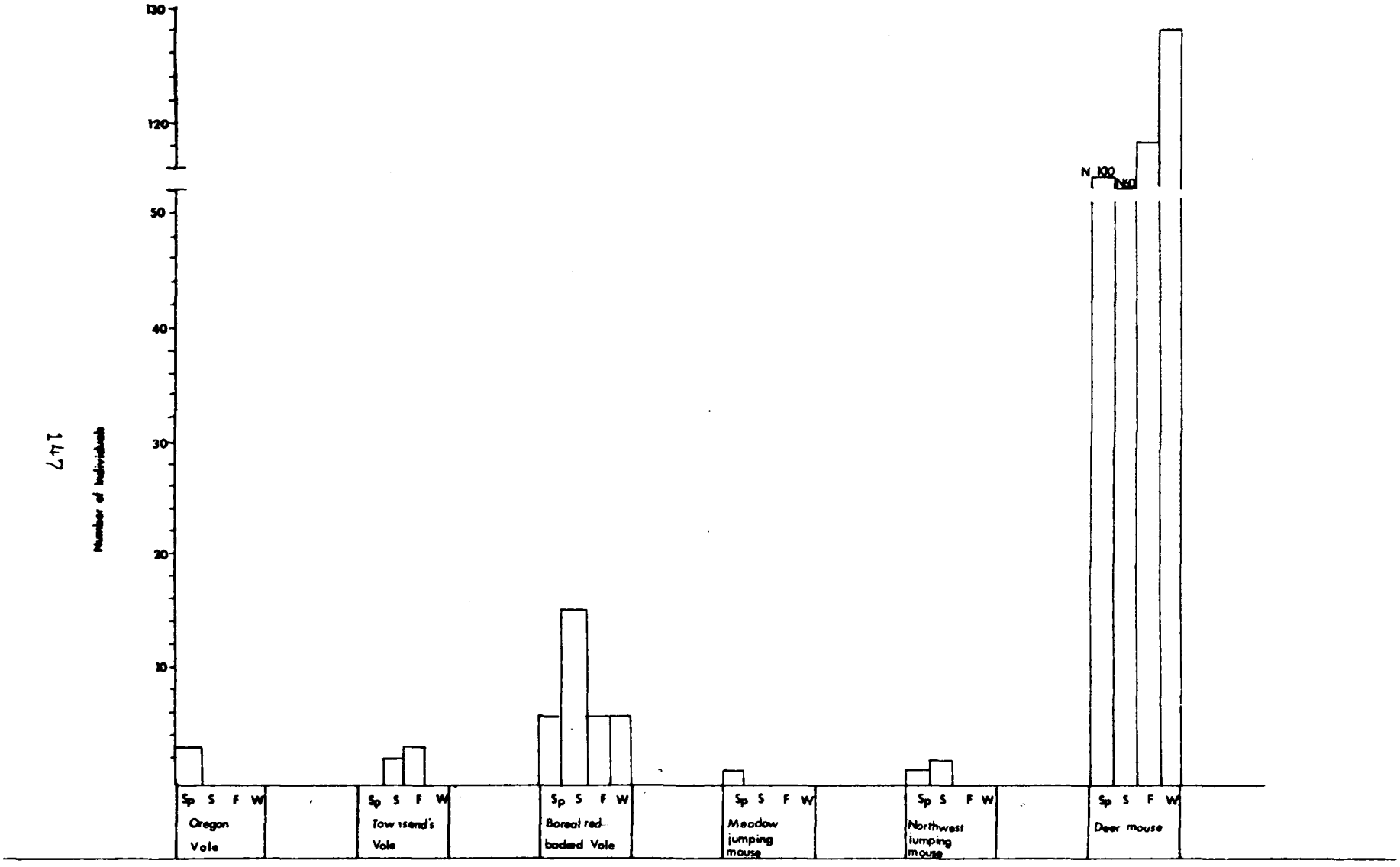


Figure 16. Numbers of voles and mice captured on all study sites by season.

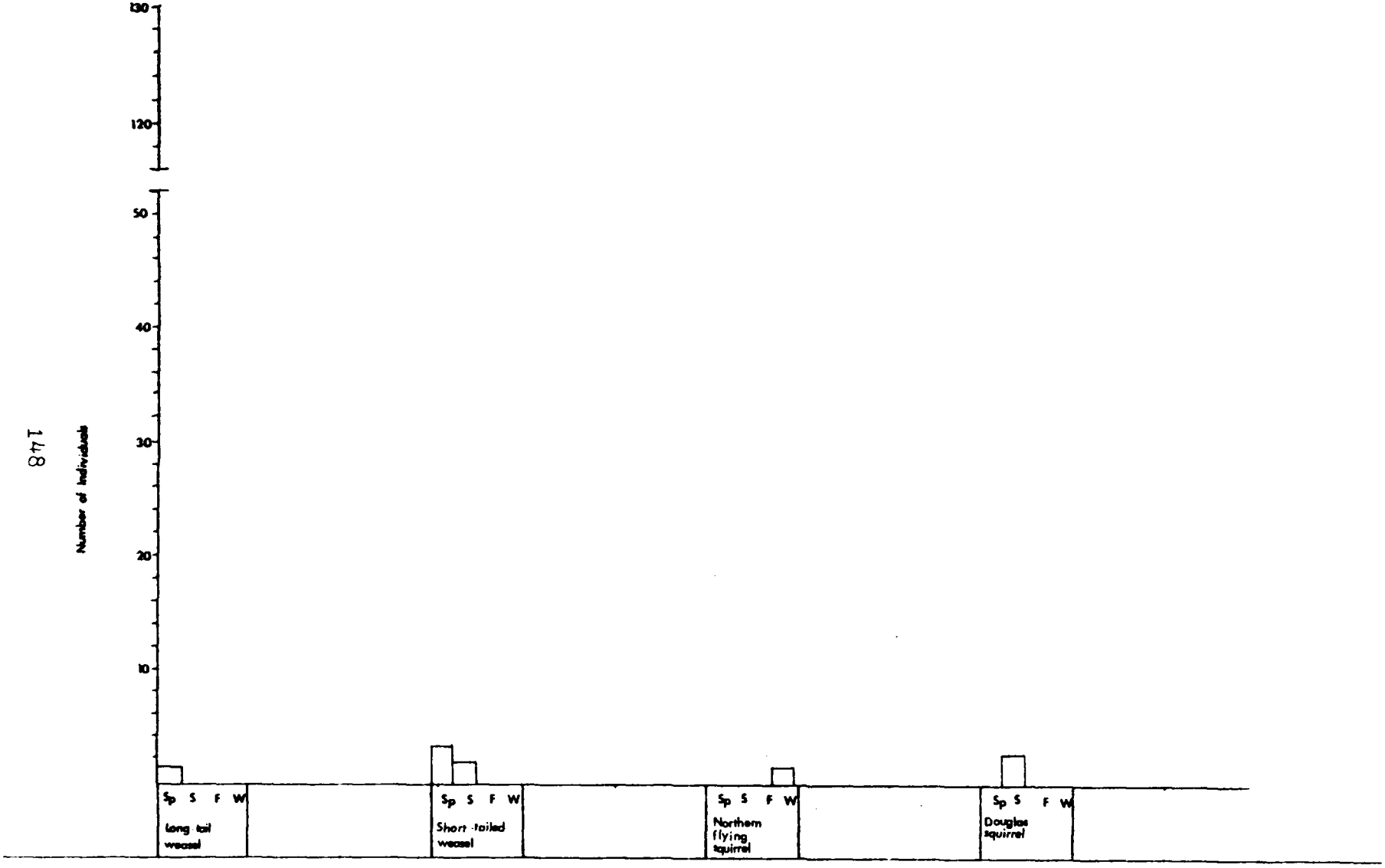


Figure 17. Numbers of weasels and squirrels captured on all study sites by season.

Table 40. Small mammal species list for 11 study sites in Grays Harbor area.

Species	1	2	3	4	5	6	7	8	9	M	MC	Total	Rank
Masked shrew	X	X	X	X	X	X	X	X	X	X		10	2
Dusky shrew		X			X							2	7
Vagrant shrew	X	X	X	X	X	X	X	X	X	X	X	11	1
Trowbridge shrew	X	X	X	X	X	X	X	X	X			9	3
Pendire shrew									X	X		2	7
Shrew-mole		X	X	X	X	X			X			6	4
Oregon vole		X										1	8
Townsends vole				X	X							2	7
Boreal redbacked vole	X			X		X					X	4	5
Meadow jumping mouse			X									1	8
Northwest jumping mouse				X				X		X		3	6
Deer mouse	X	X	X	X		X	X	X		X	X	9	3
Long-tailed weasel							X					1	8
Short-tailed weasel									X		X	2	7
Northern flying squirrel							X					1	8
Douglas squirrel											X	1	8
Black rat			X									1	8
TOTAL	5	7	7	8	6	6	6	5	6	5	5		

in spring; 11 trapped in summer; six trapped in fall and seven trapped in winter. This information corresponds to 203 individuals captured during the spring sample period, 153 captures during summer, 147 captures during fall and 160 captures during winter.

Most of this area supports a high diversity of small mammals relative to isolated freshwater marshes (Table 41) (Feldhamer 1977). Of the 20 species of small mammals that occur in this area according to Ingles (1965), 16 are found on these study sites. The black rat is not supposed to occur here. The diversity of habitat types required by these animals is further evidence of the complex structure of cover types present on these proposed fill areas.

Because small mammals are important components of the diets of mammalian and avian predators, this diversity probably accounts for (at least in part) the presence of fox, coyote, bobcat, and other predators on these study sites. Small mammals are an important part of the diet of coyote, fox, bobcat, red-tailed hawk and many other predatory animals (Caras 1967, Fairley 1965, Cowan and Guiguet 1978, Gabrielson and Jewett 1970).

Small mammals also play a role in nutrient recycling and soil stabilization. In wetlands, small mammal below ground activity will be limited to those areas above the water table or in vegetation.

Table 41. Diversity values of small mammal communities, Grays Harbor, Washington.

Season	Study Sites										
Spring	15.8	8.9	10.1	22.5	10.3	31.1	15.8	7.3	2.2	0	5.1
Summer	8.6	2.4	13.9	14.8	7.4	14.8	2.0	2.4	3.5	11.0	16.5
Fall	9.3	5.7	17.0	12.4	6.1	8.3	7.1	7.0	2.2	34.0	20.2
Winter	17.1	3.6	22.0	19.4	4.6	11.1	18.3	12.2	3.0	13.0	11.4
Average	12.7	5.2	15.8	17.3	7.1	16.3	10.8	7.7	2.7	14.5	13.3

Aquatic and Terrestrial Furbearers

Deer tracks were observed on seven scent stations (Table 42). Two stations (Weyerhaeuser log yard and Redi-Mix cement plant) showed no sign of deer use, probably due to the industrial use of these areas. A youth detention center was constructed on the site of the Redi-Mix scent station shortly after the station was developed. This station was not used after August 1980. Deer were the most abundant big game species on the study area. Their presence were recorded almost daily on most scent stations.

Rain, vandals, trailbikes, and free roaming domestic dogs, greatly reduced the effectiveness of scent stations. Station 1 was abandoned after being repeatedly destroyed by vandals. Domestic dogs used station 1, Junction City, and Redi-Mix repeatedly, masking other tracks. Rain also reduced the effectiveness of scent stations by making prints unidentifiable. In addition to the above problems, the high cost to maintain scent stations made their operation, over a prolonged period, infeasible.

Scats of terrestrial furbearers were collected and broken down into identifiable components (Table 43). Standing water and heavy rain limited the time scats were available for collection. Aquatic furbearer scats were not collected, although many beaver, muskrat, nutria and to a lesser degree, river otter scats were observed. Limited time and resources did not allow an extensive food habit study on terrestrial or aquatic furbearers.

Table 42. Species present on nine scent stations located near Junction City, Grays Harbor County, Washington.

Species	Scent Station 1	3	N.N.[a]	J.C.[b]	4	5B	8	Wey	Redi-Mix
Canidae	X			X			X		X
Coyote									X
fox	X								
domestic dog	X			X					X
Felidae									
Bobcat	X								
Domestic cat								X	
Mustelidae	X				X		X		
Mink							X		
Long-tailed weasel							X		
River otter		X							
Raccoon		X							
Deer	X	X	X	X	X	X	X		

[a] No Name Slough. See Figure 2.

[b] Junction City

Table 43. Items found in scats of bobcats and dogs (domestic, fox, coyote) collected on the Junction City study area during summer and fall, 1980, Grays Harbor County, Washington.

	Bobcat	Canids
Bones		
Mammal	X	X
Bird		X
Hair	X	X
Grass	X	X
Fir and spruce needles	X	X
pebbles	X	X
Miscellaneous	Twist tie[1]	

[1] Metal wire covered with paper.

Necropsies performed on a beaver, muskrat, river otter and Townsend's vole indicated each animal was healthy before death. A necropsy on an eastern cotton-tail rabbit indicated it died from a lung worm infestation. In addition, it suffered from pneumonia and several lesions located on the internal surface of the abdominal walls. A lung worm sample was sent to a parasitologist for identification; however, no answer has yet been received.

A heavy parasite infestation could be an indication eastern cotton-tails have too high a population; while beaver, muskrats, river otter, and Townsend's vole have not reached a high in their population cycles.

Spotlighting for aquatic and terrestrial furbearers proved to be of little use. One muskrat, one beaver, and no terrestrial furbearers were seen during 41 hours of spotlight surveying. Shining over muskrat and beaver habitat caused beavers to dive. Limited visibility was believed to be the major factor causing low success for terrestrial furbearers. Coyotes and foxes were heard during the spotlight surveys but none were seen.

Terrestrial furbearers, primarily fox, raccoons, and coyote, frequently utilized the study site foraging for food. Many observations of fox and raccoon sign were made along railroads, roads, sloughs, and trails; coyote tracks were seen less frequently. The amount of sign observed suggests a moderate population of both coyotes and raccoons, and a high population of fox.

Only 3 fox were trapped during the 1980-81 season in Grays Harbor County; one was taken from this area.

During a (USFWS) waterfowl census flight, all major marshes were located. Later, ground surveys were conducted to determine level of mammal activity. Table 44 presents beaver structures found during surveys conducted in the area. Due to the dense vegetation, many lodges, dams, and dens may not have been found during ground surveys. It is common practice to use the number of active lodges multiplyed by the theoretical number of beaver per lodge (usually 5.1) to obtain a population estimate. However, Mike Thornley[1], (pers. comm.), has found this technique invalid for estimating western Washington beaver populations. Primarily because most western Washington beaver prefer bank dens to lodges. Dens are difficult to locate and therefore difficult to count accurately.

Track surveys were conducted on three major sloughs around Junction City, Wa. (Table 45). Data indicate that smaller sloughs such as site 4 and No Name, were used more extensively than the larger ones such as 5 (Elliott) (Table 45). Small sloughs are utilized by furbearers as feeding areas (river otter, raccoon, coyote, etc.) and travel lanes (river otter, beaver, and muskrat). They also supply water to the freshwater marshes which supported populations of beaver, muskrat, and nutria.

---

[1] Mike Thornley, Washington Dept. of Game, Olympia, WA.

Table 44. Number of beaver dams, dens, and lodges found on four marsh systems located on the Junction City study area, Grays Harbor County, Washington.

Sites	Marsh locations by site: Aberdeen Junction	9[1]	5, 5B	9[2]	Sloughs[3]
Lodges					
Active	2	2	4	2	1
Non-active			3		
Dens					
Active	1		2	1	5
Non-active			4		6
Dams					
Major	2	1	2	2	1
Minor	8	5	9	5	4

[1] East of logging road running north/south through study site 9.

[2] West of logging road running north/sough through study site 9.

[3] All sloughs located in proposed dredge spoils disposal site 17.

Table 45. **Number of tracks of each species observed during track surveys conducted on 3 sloughs in the Junction City study area,** Grays Harbor County, Washington.

Species	Slough		
	No Name	Elliott	Site 4
Deer	3	4	1
Beaver	9	2	4
Muskrat	2		8
River otter	3	1	1
Raccoon	3	4	1
Opossum		1	2
Coyote	1	1	

Beaver and nutria were live trapped between October 29, 1980 and December 4, 1980 (Table 46). Success was relatively high for the first two weeks, then declined drastically. The decline was attributed to the start of the general trapping season on November 22, 1980. No beaver or nutria were captured after this date.

The large size of a Bailey live trap (1 X 1.3 m) was a great disadvantage when competing with leg hold and "conibear" (killer) type traps. Trappers can trap in more productive areas by using leghold traps, (eg. dams, dens, lodges, deep wate) then we could with Bailey traps. Bailey traps require 15-25 cm of water restraining their use to wide points in travel lanes. Much of the area trapped was influenced by tidal action.

No muskrats were live trapped during this project because tags for muskrats did not arrive in time. However, one female was captured in a Bailey beaver trap. She apparently attempted to escape, became entangled, and drowned. The presence of feeding beds, tracks, and other sign indicate that site 17 is extremely important to muskrat.

Two adult, male raccoons were marked and released on No Name slough November 4th and 6th, 1980 (Table 44). No tagged beaver, nutria, or raccoons were trapped during the general trapping season.

Table 46. Site and times beaver, nutria, and raccoon were live trapped, marked, or released on the proposed dredge spoils disposal site 17, Junction City, Grays Harbor County, Washington.

Date	Study Site	Tag Number	Species	Age
10/30	9	692	Beaver	Adult
10/31	5		Muskrat	Adult
11/4	9	697	Nutria	Adult
11/4		696	Raccoon [a]	Adult
11/5	9	694	Nutria	Adult
11/6		693	Raccoon [a]	Adult
11/19	5	700	Beaver	Juvenile

[a] Transplanted to fill site 18 released at No Name slough.

Eighty-three questionnaires were mailed to resident trappers of Pacific and Grays Harbor counties (Table 47, Appendix B). Four of seven trappers active during the 1980-81 season trapped on the study area. Table 48 shows the number and species trapped in the study area during the 1980-81 general trapping season. County trapping information was obtained for 1980-81. Approximately 41.4 ac. of proposed dredge spoils disposal site 17 are fresh water marsh. These marshes supplied 1.9% of the beaver, 3.8% of the muskrat, 1% of the river otter, and 50% of the nutria trapped in Grays Harbor county during the 1980-81 season. Grays Harbor county has led the state in total beaver trapped per county 11 of 17 years it has been legal to trap beaver.

Limited access to the fresh water marsh systems reduce the number of trappers using the area. The network of sloughs which lead to the Chehalis River provide pathways for dispersal of aquatic furbearers into other regions of the river system. Use, by trappers, increases farther to the east where road systems increase the accessability to furbearer habitat. The high furbearer numbers found on the proposed fill site directly effects the trapping success of these locations. Both aquatic and terrestrial furbearers produce offspring which immigrate into areas with less competition, re-establishing populations in heavily trapped areas. The reduction of highly productive furbearer areas, such as this, would decrease furbearer populations in adjacent areas.

Table 47. Results of trapper questionnaires mailed to 83 licensed trappers in Grays Harbor and Pacific Counties, Washington in spring, 1981.

	Numerical	Percentage
Total sent	83	
Total returned	47	57
Non-trappers (1980-81)	40	85
Active trappers (1980-81)	7	15
Active trappers (1980-81) within Junction City study area	4	

Table 48. Value of and species of furbearers trapped by four trappers on Junction City study area, Grays Harbor County, Washington in 1980-81 season.

	Total[a] Value	Number trapped (1980-81)	County Total (1980-81)	Percent of total
Beaver	607.89	23	1,199	1.9
Muskrat	269.78	47	1,237	3.8
Nutria	267.33	21	42	50.0
Fox	61.45	1	3	33.3
River otter	36.52	1	113	1.0
Bobcat	73.68	1	68	1.5
TOTAL	1316.65			

[a] Estimated value (in dollars) of furs on market during 1980-81.

Both fur trappers who trap in the study area and those who do not, agree this area supports high numbers of furbearers. The fact that Grays Harbor county is a leader in total number of beaver trapped yearly indicates the suitability of the county's habitat for beaver production. Aquatic furbearer productivity is felt to be greater within the study area than comparable habitat found in other parts of the county. With the added benefit of easy dispersal into new areas, the marsh and shrub swamp systems on these sites appear to be extremely productive habitat and should be maintained.

Big Game

[illegible] transects were [illegible] during spring and fall 1980 (Table 48). They proved ineffective in this area because of rain and tidal action.

A deer drive was conducted through sites 3 and 5 on October 24, 1980 with the help of students from Gregg Hamlet College; no deer were observed.

Spotlight counts were conducted several times during the course of this study. They proved ineffective in acquiring enough information to estimate deer numbers (Table 49). Total deer observed on all sites between May 1980 and May 1981 was seven. However, deer tracks were observed almost daily on fur-bearer scent stations. Of the five hunters interviewed in Junction City, three had shot deer. Remains of one deer were found near site 5E. However, these remains may have been left by a hunter who shot the deer somewhere else.

No black bear tracks were observed on any of the scent stations. Nor were any direct observations made by members of this study. However, bear tracks, scat, and foraging remains were observed on sites 1, 4, 5, [illegible] during the summer and fall of 1980 (Table 50). Interviews with fishermen on the

Table 49. Results of spotlight surveys for black-tailed deer on or near proposed disposal sites 16, 17, 18, Grays Harbor, Washington.

Date	Mode[a]	Location[b]	Number of deer seen	Distance traveled (km)
6/4/80	Car	JC	2	3.4
6/4/80	Car	JC	0	3.4
7/24/80	Boat	C+MS	1	3.2
1/7/81	Boat	C+MS	0	3.2
1/8/81	Boat	C+MS	0	3.2
2/3/81	Foot	JC	3	3.2
4/13/81	Car	OH	0	6.4
4/14/81	Car	OH	0	6.4
4/17/81	Car	OH	0	6.4
4/21/81	Car	OH	0	6.4

[a] Mode of transportation used during survey.

[b] JC = Junction City site; C+MS = Chehalis River and Dry Chuck Slough; OH = Old Highway between Aberdeen and Hoquiam and south of Central Park.

Table 50. Type and location of bear sign on study sites located near Junction City, Wa, during summer and fall, 1990.

Date	Site	Type of Sign
8/13	5,6	Tracks
9/20	4	Scats
9/2	4,9,5B	Tracks, scats, feeding[a]
10/2	1	Tracks

[a] An area of cattails approximately 1.2 X 3 meters was uprooted. Roots of cattails had been fed upon by the bears.

Chehalis indicate that at least one sow and cub were observed swimming the river and entering the study area. One bear has been shot in this area during each of the two previous years.

The intensity of activity observed indicate that the bears spent several days (eg. 14-28 days) in this area feeding on cattail roots, elder berries, and huckleberries. These particular plant species are utilized extensively by bears and, are abundant on the proposed fill sites.

PART VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

Junction City

Proposed dredged material disposal sites 16, 17, and 18 show a high diversity of vertebrate species. Waterfowl and marsh birds utilize this area for breeding, while waterfowl also winter on these wetlands.

Furbearers are found in all habitats within those proposed disposal areas. While marshes within the disposal sites support high populations of muskrat (425 muskrat/km^2) and beaver (66 beaver/km^2). Although population estimates on other furbearers were not possible, otter were common and fox, bobcat and bear all utilized these sites. Songbirds and small mammals were also found in abundance. These animals act as a food base for many of the predatory mammals as well as the birds of prey observed in this area.

At least 90 species of birds, 22 species directly associated with wetlands, were found on proposed disposal sites 16, 17 and 18. These sites support 23 songbirds per ha (9.3 per acre) during breeding season, and 20 songbirds per ha (8.1 per acre) on a year round basis. Four species of waterfowl nest in marshes and sloughs on these sites. Marsh on these sites had 800 waterfowl days per, month of use during winter. Four species of herons nest or hunt within these disposal sites. Nine species of raptors were seen on two square kms (0.8 square miles). Disposal sites 16, 17 and 18 are classified as wetlands and critical to wildlife (ACOE 1975).

Hunting for pigeons, ducks, grouse, bear, and deer occurs on these sites. Many of these hunters are teenagers with no transportation to travel to more remote areas. Trapping is probably the most widespread consumptive activity on these sites.

Because of the difficulty of appraising the value of wetlands (Smith 1978) and of placing economic values on aesthatics, nonconsumptive use, and limited consumptive use, it would not be easy to place a dollar value on these lands. However, the importance of our coastal and inland wetlands has been recognized on the national level. Executive Order 11990 issued by President Carter on 24 May 1977 called for the preservation of wetlands on all federal lands when any alternative for development was present. Additionally, the president stated, "The nations coastal and inland wetlands are vital natural resources of critical importance to the people of this country." Wetlands supply natural diversity, flood control, and bank stabilization, at no cost to the public.

The wetlands in these sites probably fulfill these functions. In addition because of the degree of interspersion and size of cover types, their ecological value is high. Small marshes with high interspersion have been shown to have high value (Gueinski 1978).

Therefore, due to man's general inability to predict the consequences of environment changes, and to look at the parts and not the whole (Bella 1974), we recommend the Junction City

sites not be used for disposal of dredge materials. Realizing that this may not be possible, we have identified those areas, the loss of which would have the least impact on this wetland/upland system (Figure 18). Filling should be conducted between September and November when breeding of birds and mammals is completed. If filling does occur, mitigation and/or compensation would be required. Several possible mitigation sites have been identified (Figure 19).

Mitigation Sites, Location by Township (T), Range (R) and Section

A. T.17 N.-R.8W. Section 13: approximately 132 ha agricultural land.

B. T.17 N.-R.8 W. Section 14: approximately 12.5 ha agricultural land.

C. T.17 N.-R.8 W. Section 23: approximately 50 ha gravel operation.

D. T.18 N.-R.11 W. Sections 15, 21, 22: approximately 120 ha diked pasture.

E. T.16 N.-R.11 W. Sections 19, 20, 29, 30: Approximately 130 ha diked pasture, saltmarsh, wooded swamp.

Each of these areas has advantages and disadvantages. Areas A, B, and C would offer compensation by replacement of wetlands within the same systems as they would be removed. Area C, a gravel pit, would be advantageous, in that after gravel

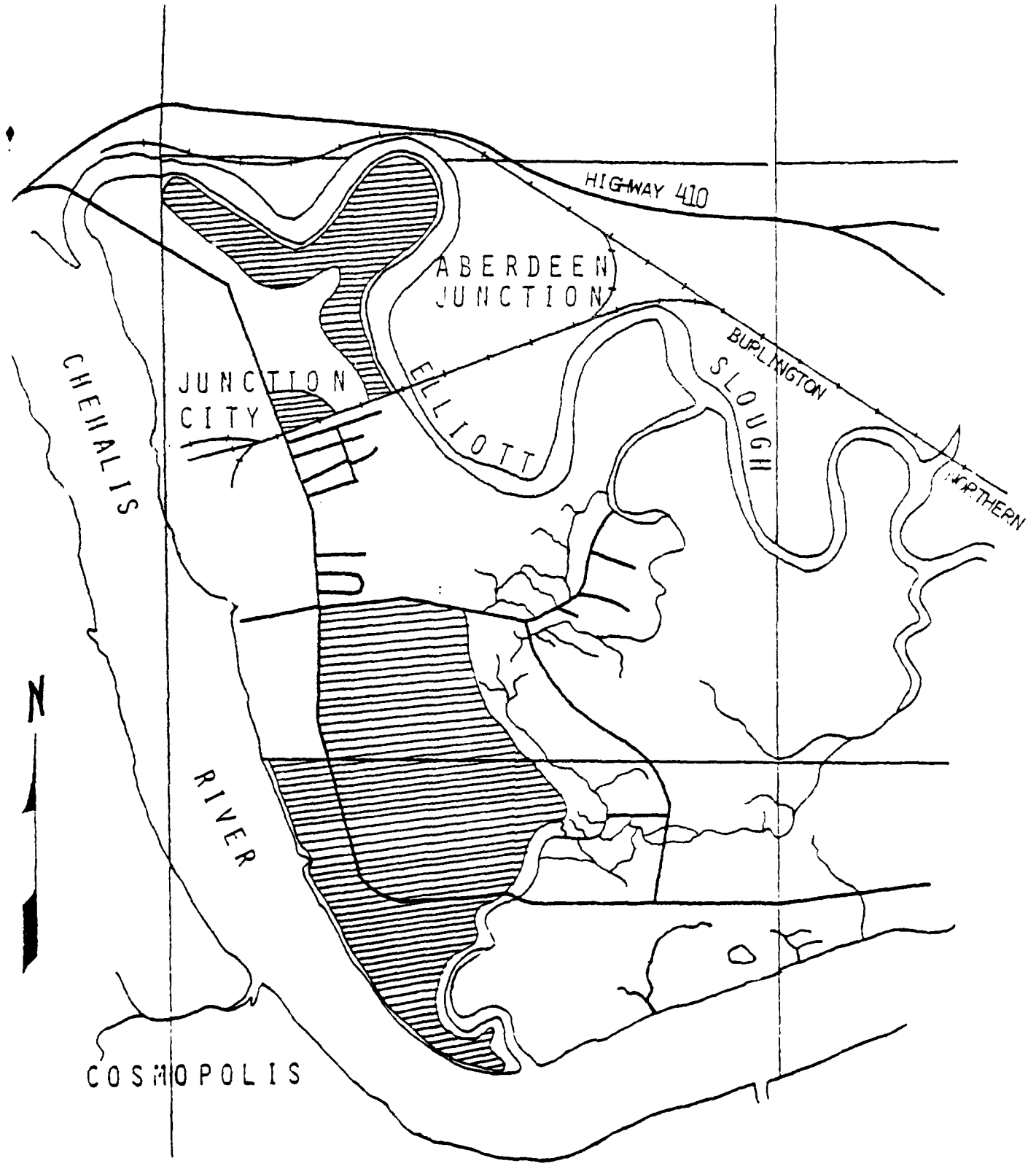


Figure 18. Areas (hatched) near Junction City, Washington where disposal of dredge material would have the least significant impact on wildlife resources.

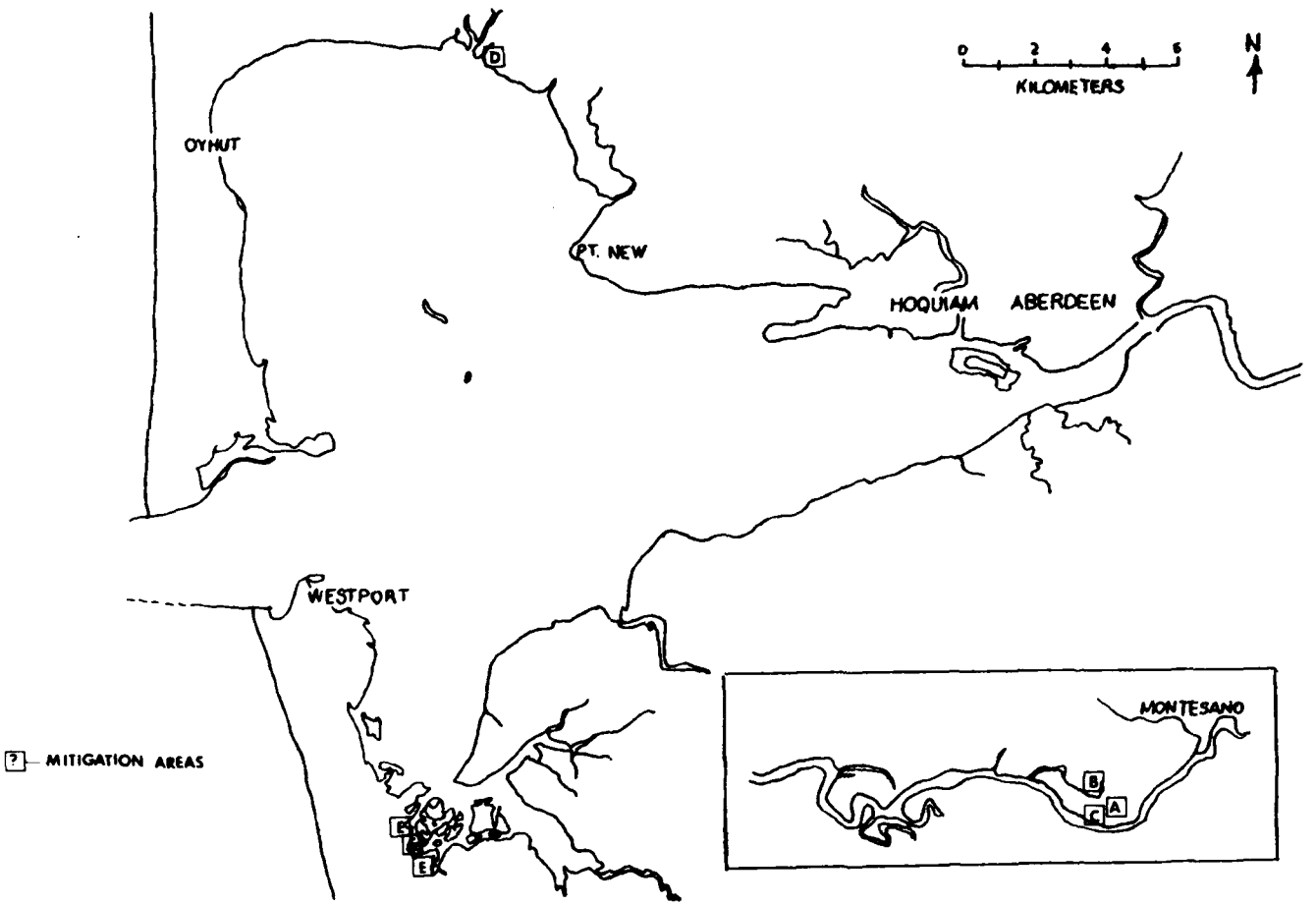


Figure 19. General location of five areas containing possible mitigation sites for Grays Harbor Deepening and Widening upland disposal sites near Junction City, Washington.

extraction is completed, the hole could be used for dredged material disposal. This in turn would build up the area to an elevation where it could again support wetland plants and animals. Using areas A and B for mitigation would remove land from agricultural production.

Area D would provide a large wildlife area adjacent to existing Department of Game holdings at the mouth of the Humptulips River. In addition, breaching the dikes would allow marsh plants to reestablish. However, this area is not in the same drainage as the designated fill sites.

Acquisition of mitigation site E would protect part of the Elk River marsh system from development. Disadvantages are: this area is not in the Chehalis River system, nor is it near any large Department of Game holdings.

Acquisition and habitat restoration on areas A, B, or C would result in replacement in kind. Whereas areas D and E would result in replacement in lieu. Primary habitat on these latter two areas is salt marsh.

Cosmopolis Reach

The Chehalis River and sloughs proximal to the Cosmopolis Reach support at least 46 species of waterbirds. Waterfowl use peaked during winter. River marshes and upper sloughs were preferred areas. Western grebes were abundant during winter and spring, with numbers peaking during high tides. Bald eagles and

waterfowl will not be directly impacted by dredging. Most use is more than five kms upstream from proposed dredging. Fish-eating waterbirds, mergansers and gulls commonly used the Cosmopolis Reach. Numbers were lowest during summer and fall.

Recommendations

1. Dredge during ebb tides to minimize the amount of time pollutants and particulates are in the river.
2. Dredge from September to November when bird numbers are lowest. Turbidity from dredging may adversely affect birds by reducing their ability to find food.

Salt Marsh Establishment

Fifty-four species of birds were observed using tideflats or salt marshes along the south shore, inner harbor. Waterfowl use peaked during fall migration. Most shorebird use was during spring migration. Bird numbers were dramatically higher west of the salt marsh establishment site than on the site. Aerial censuses also indicated that winter shorebird and waterfowl use was less than in other areas. Food habits studies showed that seeds of salt marsh plants are highly valuable to dabbling ducks and sandpipers. Observations of feeding waterfowl showed that salt marshes at lower elevations are more valuable to waterfowl than similar marshes at higher elevations. Bald eagles were observed 11 times

between Newskah Creek and Stafford Creek. Six of the bald eagles were perched in a snag at site M.

Negative impacts on birds of covering 8-20 ha of tideflat with dredged material will be low considering the low numbers observed using the salt marsh establishment site. Similarly, positive impacts on birds will probably be low. Salt marshes are important habitat. Since there is less salt marsh than tideflat on Grays Harbor, overall value of the estuary to birds should increase.

Recommendations

1. If possible, construct shore edge of salt marsh at lowest elevation at which Carex lyngbyei and Triglochin maritimum can tolerate (about 2.1 above MLLW). This would maximize its value to dabbling ducks.
2. Leave the bald eagle snag, at east edge of site, undisturbed.
3. Construct salt marsh between mid-May and mid-August when bird use is lowest.

Food Habits

Waterfowl

Wintering pintails and mallards in Grays Harbor depended heavily on intertidal invertebrates. Amphipods comprised 62.9% of the food items taken by pintails. Corophium (58.9%) and

Eogammarus confervicolus (3.3%) were important. Seeds of salt marsh plants, mostly Triglochin maritimum and Carex lyngbyei, comprised 33.7% of food items taken. Amphipods comprised 92.6% of the food items found in three mallards. E. confervicolus (87.6%) and Corophium spp. (5.0%) were important. Seeds (5.8%) supplemented amphipods as food items. American wigeon fed primarily on eelgrass (Zostera spp.). Available literature (Martin, Zin, Nelson 1951, Yocum and Keller 1961, and Guiguet 1978) indicate the plants are most important food items of waterfowl. Connelly and Chessmore (1980) indicate invertebrates are more important and that this fact is evident when using esophagi rather than gizzards as a source of material for analysis.

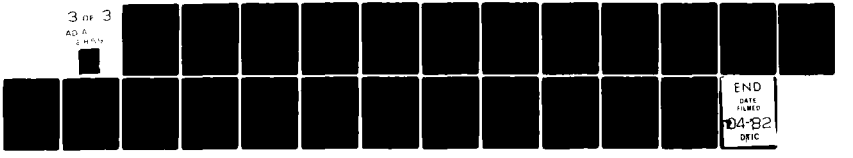
Shorebirds

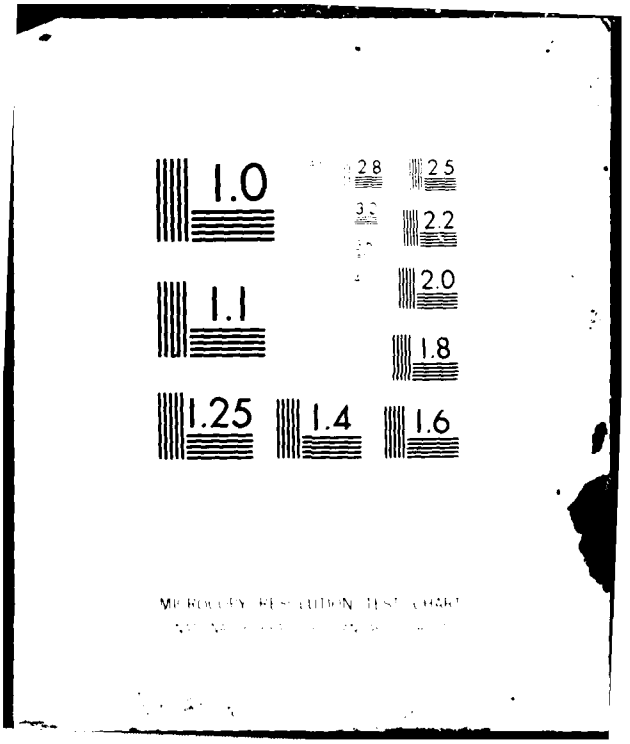
Dunlin in Grays Harbor fed mostly on Corophium spp., tanaids, Eogammarus confervicolus, insect larvae, and polychaetes. Corophium spp. occurred in 50% of all esophagi with contents. Western sandpipers consumed mostly oligochaetes, seeds of salt marsh plants and amphipods. Three sanderling contained mostly oligochaetes.

Recommendations

1. Further food habits research, on waterfowl feeding in this estuary, needs to be done to clarify the importance

AD-A112 859 WASHINGTON STATE DEPT OF GAME ABERDEEN F/G 13/2
GRAYS HARBOR AND CHEHALIS RIVER IMPROVEMENTS TO NAVIGATION ENVI--ETC(U)
JAN 82 S A KALINOWSKI, R C MARTIN, L D COOPER DACW67-80-C-0091
UNCLASSIFIED NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

of invertebrates as food items of waterfowl. Collection of specimens at intermediate tide levels, well away from salt marshes, would increase our knowledge of the importance of intertidal invertebrates to waterfowl.

LITERATURE CITED

LITERATURE CITED

ACOE. 1971. Floodplain information - Chehalis, Wishkah, and Hoquiam rivers Aberdeen-Hoquiam-Cosmopolis, Washington. Corps of Engineers, U.S. Army, Seattle, Washington. 39 p.

ACOE. 1975. Washington environmental atlas. U.S. Gov't. Printing Off., Washington, D.C. 115 p.

American Ornithologists' Union. 1957. Check-list of North American birds. Port City Press, Inc., Baltimore, Maryland. 691 p.

Bandi, Z. and N.A. Kenny. 1974. A Simple Method for Saponification and extraction of long and medium chain stool lipids. Clin. Chem. 20:873.

Bellrose, F.C. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, Pa. 540 p.

Bella, D.A. 1974. Fundamentals of comprehensive environmental planning. Eng. Issues - J. of Professional Activities ASCE. 100(EI1):17-36.

Brewer, L.W. 1980. The ruffed grouse in Western Washington. Washington State Dep. Game. Biol. Bull. 16. 197 p.

Buckley, Francine G. and Cheryl A. McCaffrey. 1978. Use of dredged material islands by colonial seabirds and wading birds in New Jersey. Manomet Bird Observatory. Technical report D-78-1.

Caras, R.A. 1967. North American mammals, fascinating animals of the United States and Canada. Meredith Press. New York, N.Y. 428 p.

Connelly, P.I. and T.E. Chesemore. 1980. Food habits of pintail, Anas acuta, wintering on seasonally flooded wetlands in the northern San Joaquin Valley, Calif. J. Calif. Fish and Game. 66(4):234-239.

Couch, A.B. 1967. Feeding ecology of four species of cormorants in western Washington. M.S. Thesis, Univ. of Wash., Seattle. 67 p. (cited by Smith 1976)

Dillery, P.G. 1965. Post-mortem digestion of stomach contents of the Savannah sparrow. Auk. 82(2):281. (cited by Smith 1976)

Eddy, P.A. 1966. Geology and ground-water resources of the lower Chehalis river valley and adjacent areas. Div. of Water Resources, Olympia, Wa. 70 p.

Emlen, J.T. 1971. Population densities of birds derived from transect counts. Auk. 82:323-342.

Fairley, J.S. 1965. The food of the fox Vulpes vulpes cc., in co. down. Irish Naturalist J. 15(1):2-5.

Feldhamer, G.A. 1977. Factors affecting the ecology of small mammals on Malheur National Wildlife Refuge. Ph.D. Thesis. Oregon State University, Corvallis, OR. 63 p.

Fitzner, R.E., W.H. Rickard, and D.E. Clark. 1978. Herpetological survey at the trojan nuclear plant, Oregon. Northwest Science, 52(2):104-107.

Gabrielson, I.N. and S.G. Jewett. 1970. Birds of the Pacific Northwest. Doven Publ. New York, N.Y. 650 p.

Gatlo, L.W. 1978. Estuarine processes and intertidal habitats in Grays Harbor, Washington. A demonstration of remote sensing techniques. U.S. Cold Regions Research and Engineering Laboratory, Springfield, Va. CREEL Report 78-18. 79 p.

Gentry, J.B., F.B. Golley, and J.T. McGinnis. 1966. Effect of weather on captures of small mammals. American Midland Naturalist 75:526-530.

Giles, R.H., (ed.). 1969. Wildlife management techniques. 3rd ed. The Wildl. Soc., Washington, D.C. 623 p.

Gueinski, H. 1978. A note on the relation of size to ecological value of some wetlands. Estuaries 1(3):151-156.

Guiguet, C.J. 1978. The birds of British Columbia, (6) waterfowl. Handbook No. 15. British Columbia Provincial museum. Victoria. 84 p.

Gullion, G.W. and W.H. Marshall. 1968. Survival of ruffed grouse in a boreal forest. Paper No. 6173, Sci. J. Serv., Minnesota Agr. Exp. Sta., Univ. Minn., St. Paul. (cited by Brewer 1980).

Hungerford, K.E. 1953. A ruffed grouse drumming count technique for northern Idaho conditions. Research notes - Forest Wildl. Range Exp. Sta., Univ. Idaho. Note No. 10. (cited by Brewer 1980)

Knight, R.L., and A.W. Erickson. 1976. High incidence of snakes in the diet of nesting red-tailed hawks. Raptor Research. 10(4):108-111.

Korschgen, L.J. 1971. Procedures for Food-Habits Analysis. From Wildlife Manage. Tech. Giles JR editor.

Larimer, E.J. 1968. An investigation of possibilities for creating saltmarsh in the estuaries of the Atlantic and Gulf coasts. Southeastern Assoc. of Game & Fish Commissioners. Proceedings, 22nd Annual conference:82-88.

Lindzey, F.G., S.K. Thompson and J.I. Hodges. 1977. Scent station index of black bear abundance. J. Wildl. Manage. 41(1):151-153.

MacArthur, Robert H. and J.W. MacArthur. 1961. On bird species diversity. Ecology. 42(3):594-598.

MacArthur, R.H. 1964. Environmental factors affecting bird species diversity. American Naturalist. 98(903):387-397.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American wildlife and plants - a guide to wildlife food habits. Dover Publ. Inc. New York. 484 p.

Meyer, P.A. and D.R. Dolphin. 1977. A system for determining economic loss associated with estuary degradation. Coastal zone manage. J. 3(4):385-405.

Murie, O.J. 1974. A field guide to animal tracks. Houghton Mifflin Co. Boston. 375 p.

Neff, D.J. 1968. The pellet-group count technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32(3):597-614.

Nelson, W.H., S. Kalinowski, and L. Lynam. 1980. Grays Harbor and Chehalis River improvements to navigation environmental studies. U.S. Army Corps of Engineers. Contract No. DACW67-79-M-1788.

Osborn, D.J. 1955. Techniques of sexing beaver, Castor canadensis. J. Mamm. 36(1):141-142.

Parnell, J.F., D.M. DuMond, and R.N. Needham. 1978. A comparison of plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries. University of North Carolina at Wilmington, Dept. of Biol. Technical report D-78-9.

Peterson, R.T. 1961. A field guide to western birds. Houghton Mifflin Company, Boston. 309 p.

Proctor, C.M., J.C. Garcia, D.V. Galvin, T. Joyner, G.B. Lowis, L.C. Loehr, and A.M. Massa. 1980. An ecological characterization of the Pacific Northwest coastal region. 5 vol. U.S. Fish & Wildlife Service, Biological Services Program. FWS/OBS-79/11 through 79/15.

Recher, H.F. 1969. Birds species diversity and habitat diversity in Australia and North America. The American Naturalist 103(929):75-80.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor. 82:309-313.

Robbins, C.S., B. Bruun, and H.S. Zim. 1966. A guide to field identification: birds of North America. Golden Press. New York, N.Y. 340 p.

Rush, D.H. and L.B. Keith. 1971. Ruffed grouse-vegetation relationships in central Alberta. J. Wildl. Manage. 35:417-429. (cited by Brewer 1980)

Schreiber, R.W. 1978. Colonial bird use and plant succession on dredged material islands in Florida. Volume 1: Sea and wading bird colonies. Seabird Research, Inc., Calif. Technical report D-78-14.

Slater, J.R. 1963. A key to adult reptiles of Washington state. Univ. of Puget Sound occ papers nos. 23, 24:209-232.

Slater, J.R. 1964. A key to adult amphibians of Washington state. Univ. of Puget Sound. occ papers nos. 25,26:235-242.

Small, J. 1970. Estuaries and the ecology of shorebirds. Trans. N. Am. Wildl. Conference. 35:258-264. (cited by Smith and Mudd 1976)

Smith, R.V. 1980. Problems/controls in the appraisal of wildlands. The Appraisal J:215-225.

Smith, H.K. 1978. An introduction to habitat development on dredged materials. Synthesis report. U.S. Army Engineer Waterways Exp. Station. Technical Report DS-78-19.

Smith, J.L., R. Albright, and A.D. Rammer. 1976. The effect of intertidal dredged material disposal on benthic invertebrates in Grays Harbor, Washington. In Maintenance dredging and the environment of Grays Harbor. Appendix E. U.S. Army Corps of Engineers, Seattle District. 244 p.

Smith, J.L. and D.M. Mudd. 1976. Impact of dredging on the avian fauna in Grays Harbor. In Maintenance dredging and the environment of Grays Harbor, Appendix H. U.S. Army Corps of Engineers, Seattle District. 106 p.

Sokal, R.R. and F. J. Rohlf. 1969. Biometry. W.H. Freeman and Company Inc., San Francisco. 776 p.

Swanson, G.A., and J.C. Bartonek. 1970. Bias associated with food analysis in gizzards of blue-winged teal. J. Wildl. Mgmt. 34(4):739-746. (cited by Smith and Mudd 1976)

Swanson, G.A. 1977. Diel food selection by Anatinae on a waste-stabilization system. J. Wildl. Manage. 41(2): 226-231.

Tanner, J.T. 1978. Guide to the Study of Animal Populations. The Univ. of Tenn. Press. 186 p.

Vincent, M.K. 1978. Habitat development field investigations, Rennie Island marsh development site, Grays Harbor, Washington. Summery report. U.S.Army Engineer Waterways Exp. Sta., Environ. Effects Laboratory. Technical report D-78-11.

Yocom, C.F., and M. Keller. 1961. Correlation of food habits and abundance of waterfowl, Humboldt Bay, California. Calif. Fish and Game. 47(1):41-53. (cited by Smith and Mudd 1976)

APPENDICES

Appendix A. Cover type descriptions from Nelson, Kalinowski, and Lynam 1950.

42 Broadleaf Forest. As the name implies, this designation is assigned to areas where broadleaf deciduous species comprise 80 percent or more of the canopy. Regenerating conifers in the subcanopy are typical of the broadleaf forest. A diverse ground cover may be present. Broadleaf species typically occupy wetter sites than do conifers. Characteristic species of this vegetative type include red alder (Alnus rubra), willow (Salix spp.) and big leaf maple (Acer macrophyllum). These are important areas for wildlife.

423 Mature Broadleaf. This designation covers a forest age class greater than 45 feet in height with a well-developed subcanopy and ground cover present.

61 Aquatic Land - Forested. Areas included in this designation have surface or standing water during some portion of the year and are at least partially forested. Inhabitants of swamps include pileated woodpeckers, wood ducks, ruffed grouse, bald eagles, black bear (Euarctos americanus), and black-tailed deer (Odocoileus hemionus columbianus). Forested aquatic lands are generally divided according to salinity into either intertidal brackish swamp or freshwater swamp. Only freshwater swamp is present in the Chehalis River study area.

612 Freshwater Swamp. Freshwater swamps occur in valley bottoms, along river drainages, and in other low-lying coastal areas. They usually have some open water, at least seasonally, relatively dense vegetation, and level terrain. There are two major types; tree dominated and shrub dominated. Tree dominated swamps include coniferous, broadleaf, and mixed forest. The presence of woody vegetation in swamps is a primary factor which helps differentiate them from a marsh.

Swamps in which trees, marsh, and open water areas are interspersed provide habitat for a diverse group of wetland birds, mammals, and amphibians, as well as terrestrial species. Characteristic species include wood ducks, hooded mergansers, great blue herons, pileated woodpeckers, tree swallows, chickadees, common flickers, and downy woodpeckers. Hawks and owls, coyotes (Canis latrans), bobcat (Lynx rufus), and river otter (Lutra canadensis) are examples of predatory birds and mammals which may be present. The occurrence of larger carnivores is especially dependent on the size of the swamp and the presence of suitable adjacent habitats.

6121 Shrub Swamp. Shrub dominated areas which usually have some open water at least seasonally are included in this designation. Hardhack (Spiraea douglassii), willows (Salix spp.) and crabapples (Pyrus fusca) are common shrubs. Birds commonly found in shrub swamp habitats are listed in Table 7.

61244 Mature. This designation includes an age class with trees greater than 45 feet in height. Subcanopy and ground cover are well-developed. Some old growth (trees over 150 years old) may be present.

62 Aquatic Land - Vegetated Nonforested. This designation includes wetlands which are nonforested but may be densely vegetated (e.g., marshes, bogs, meadows, and intertidal areas). The Chehalis River study is located upstream from the estuary, where vegetated nonforested aquatic lands are composed entirely of freshwater marshes. Like marine plant communities, freshwater marshes are naturally fertile systems. They are used by a large number of wildlife species including beaver (Castor canadensis), muskrat (Ondatra zibethica), river otter (Lutra canadensis), coyote (Canis latrans), raptors, waterfowl, songbirds, great blue herons, fish, benthic invertebrates, and amphibians. Some of these species live almost exclusively in marshes, while others are dependent on marshes to varying degrees.

One of the most valuable functions of marshes is their ability to moderate extreme highs and lows in streamflow.

626 Freshwater Marsh. Low areas or depressions which are not under marine influence and contain standing water for all or part of the year are designated freshwater marsh. Herbaceous vegetation is dominant. Common types include sedges (Carex sp.), grasses, rushes (Juncus spp.), cattails (Typha latifolia), reed canary grass (Phalaris arundinacea), bulrushes (Scirpus spp.), skunk cabbage (Lysichitum americanum), and purple cinquefoil (Potentilla palustris). Birds which may be found in freshwater marshes are listed in Table 7.

Appendix B. Trapper Survey and map used during Grays Harbor Improvement to Navigation Environmental Studies, 1980-81.

Please Return To: Stephan Kalinowski
Department of Game
905 E. Heron
Aberdeen, Washington 98520

1. Have you trapped on the Chehalis River or its sloughs between Aberdeen and Montesano during 1979-80 or 1980-81 seasons.
1979-80 1980-81
yes no yes no (circle your answer)

2. How many days did you have traps set in each of the four zones shown on the attached map. Put a check (✓) under the # of days in each zone.

Zone	0	1-7	8-14	# of days 12-21	22-28	more than 28 days
1						
2						
3						
4						

3. How many individuals of each of the following species did you trap in each zone.

Species	1		2		3		4	
	79-80	80-81	79-80	80-81	79-80	80-81	79-80	80-81
Beaver								
Bobcat								
Coyote								
Ermine								
Fox								
Mink								
Muskrat								
Nutria								
Rabbits								
Raccoon								
River Otter								
Spotted Skunk								
Stripped Skunk								

4. Did you trap on any of these other Rivers or Creeks?

River	Yes	No	✓
Wishkah R.			
Hoquiam R.			
Elk R.			
Newskah R.			
Charley Cr.			
Johns River			
Humptulips R.			
Grass Cr.			
Chenois Cr.			

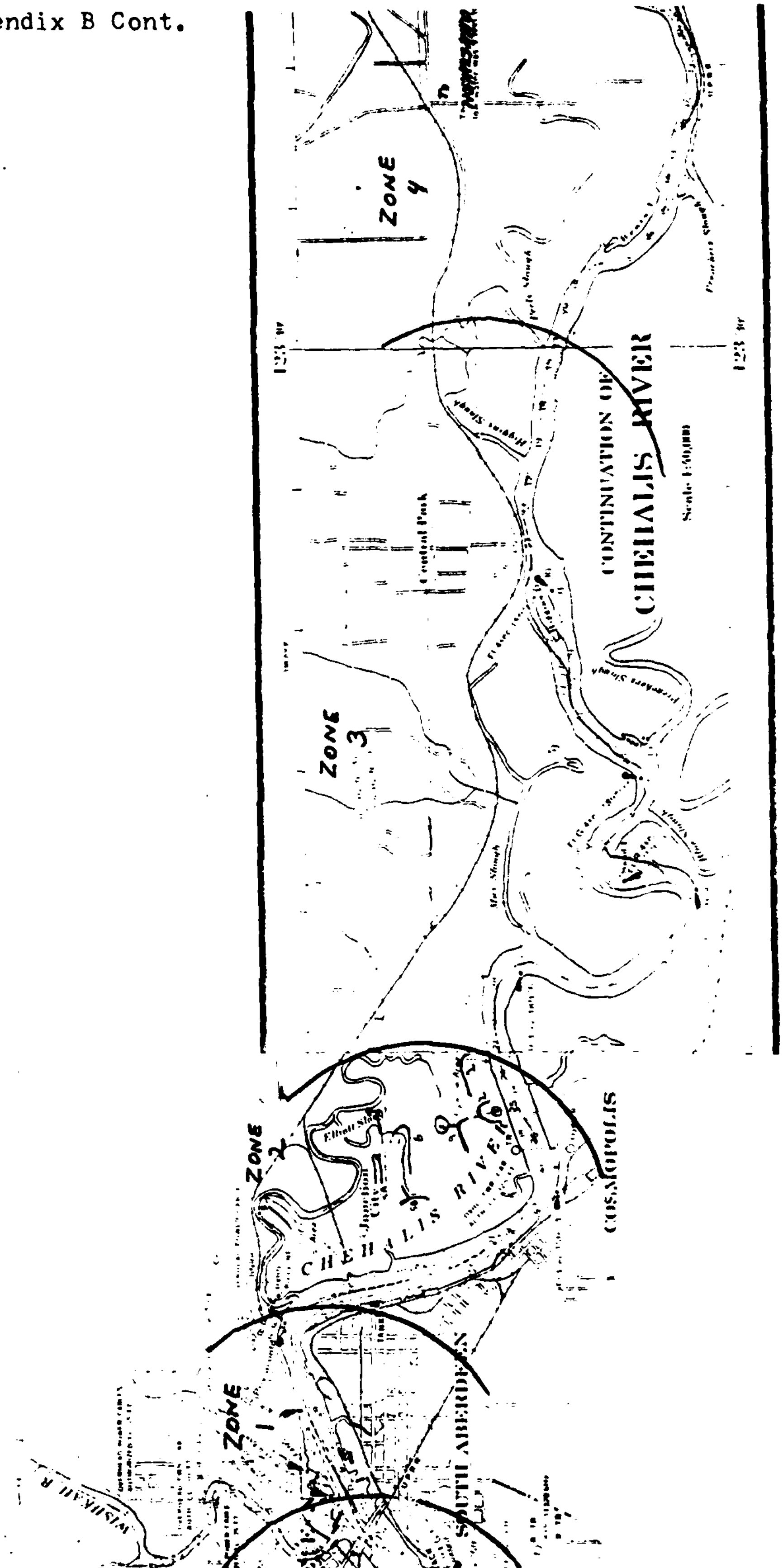
5. Please put a check (✓) next to the river or creeks which are better trapping then zone 2 on the Chehalis River.

6. Are these creeks better because (1) their easier to trap (2) closer to home, (3) trap more animals, (4) trap different species?
Please write the number of the reason that best describes why that creek is better, next to the name of that creek.

7. How many of each of the following types of traps do you normally set?

Trap type/size	# of traps water sets	land sets
Conibear #110		
120		
220		
330		
Single spring traps		
0		
1		
2		
3		
4		
Double spring traps		
1		
2		
3		
4		

Appendix B Cont.



Appendix C. Scientific names of plant species mentioned in the text of this report.

Polypodiaceae	
Polystichum munitum	sword fern
Pteridium aquilinum	bracken fern
Athyrium filix-femina	lady fern
Pinaceae	
Picea pungens	Colorado blue spruce
Picea sitchensis	Sitka spruce
Tsuga heterophylla	western hemlock
Typhaceae	
Typha latifolia	cat-tail
Cyperaceae	
Scirpus microcarpus	small-fruited bullrush
Carex lynbyei	Lyngby's sedge
C. obnuta	slough sedge
Araceae	
Lysichitum americanum	skunk cabbage
Lemnaceae	
Lemna minor	lesser duckweed
Juneaceae	
Juncus effusus	soft rush
Iridaceae	
Iris pseudacorus	yellow flag
Salicaceae	
Salix hookeriana	Hooker's willow
Betulaceae	
Almus rubra	red alder
Polygonaceae	
Rumex occidentalis	western dock
Grossulariaceae	
Ribes divaricatum	straggly gooseberry

Appendix C continued.

Saxifragaceae	
Tiarella trifoliata	foamflower
Rosaceae	
Spirea douglasii	hardhack
Potentilla spp.	cinquefoil
Potentilla pacifica	Pacific silverweed
Physocarpus capitates	ninebark
Rubus laciniatus	evergreen blackberry
R. parviflorus	thimbleberry
R. spectabilis	salmonberry
R. ursinus	Pacific blackberry
Rosa nutkana	Nootka rose
Pyrus fusca	western crabapple
Fabaceae	
Vicia gigantea	giant vetch
Aceraceae	
Acer circinatum	vine maple
Rhamnaceae	
Rhamnus purshiana	cascara
Onagraceae	
Epilobium watsonii	Watson's willow-herb
Amniaceae	
Aeracleum lanatum	cow parsnip
Conioselinum pacificum	Pacific hemlock
Berula erecta	berula
Ericaceae	
Gaultheria shallon	salal
Vacciniaceae	
Vaccinium parvifolium	red huckleberry
Labiatae	
Mentha arvensis	field mint

Appendix C continued.

Scrophulariaceae	
Veronica americana	American brooklime
Rubiaceae	
Galium aparine	cleavers
Caprifoliaceae	
Sambucus callicarpa	red elderberry
Lonicera involucrata	bearberry honeysuckle
Compositae	
Aster subspicatus	Douglas' aster
Anaphalis margaritacea	pearly everlasting
Cirsium arvense	Canadian thistle

Appendix D. Scientific names of vertebrate species mentioned in the text of this report.

Amphibians and Reptiles	
Ambystena macrodactylum	long-toed salamander
Hyla regilla	Pacific tree frog
Phethon dunni	Dunn's salamander
Rana aurora	red-legged frog
R. pretiosa	spotted frog
Taricha granulosa	rough-skinned newt
Thamnophis elegans	red-spotted garter snake
T. ordinoides	northwestern garter snake
T. sirtalis	common garter snake
Birds	
Phalacrocorax auritus	double-crested cormorant
Anas platyrhyncos	mallard
A. acuta	pintail
A. americana	American wigeon
A. clypeata	northern shoveler
A. discors	blue-winged teal
A. cyanoptera	cinnamon teal
A. carolinensis	American green-winged teal
Aix sponsa	wood duck
Mergus merganser	common merganser
Accipiter cooperii	Cooper's hawk
A. striatus	sharp-shinned hawk
Circus cyaneus	marsh hawk
Buteo jamaicensis	red-tailed hawk
B. swainsoni	Swainson's hawk
Falco peregrinus	peregrine falcon
F. sparverius	kestrel
F. columbarius	merlin

Appendix D continued.

Bonasa umbellus	ruffed grouse
Phasianus colchicus	ring-necked pheasant
Ardea herodias	great blue heron
Butorides striatus	northern green heron
Nycticorax nycticorax	black-crowned night heron
Botaurus lentiginosus	American bittern
Rallus limicola	Virginia rail
Porzana carolina	Sora
Charadrius vociferous	killdeer
Numenius phaeopus	whimbrel
Actitis macularia	spotted sandpiper
Tringa melanoleuca	greater yellowlegs
T. flavipes	lesser yellowlegs
Calidris minutilla	least sandpiper
C. mauri	western sandpiper
C. alba	sanderling
C. alpina	dunlin
Capella gallinago	common snipe
Larus glaucescens	glaucous-winged gull
L. occidentalis	western gull
L. argentatus	herring gull
L. californicus	California gull
L. delawarensis	ring-billed gull
L. philadelphia	Bonaparte's gull
Sterna caspia	caspian tern
Columba fasciata	band-tailed pigeon
Otus asio	screech owl
Tyto alba	barn owl
Glaucidium gnoma	pygmy owl
Bubo virginianus	great horned owl
Chordeiles minor	common nighthawk

Appendix D continued.

Selasphorus rufus	rufous hummingbird
Mega ceryle alcyon	belted kingfisher
Colaptes auratus	common flicker
Dryocopus pileatus	pileated woodpecker
Dendrocopos villosus	hairy woodpecker
D. pubescens	downy woodpecker
Empidonax trailii	willow flycatcher
Hirundo rustica	barn swallow
Petrochelidon pyrrhonota	cliff swallow
Tachycineta thallassina	violet-green swallow
Iridoprocne bicolor	tree swallow
Stelgidopterys ruficollis	rough-winged swallow
Cyanocitta stelleri	steller's jay
Corvus brachyrhyncos	common crow
C. caurinus	northwestern crow
Parus atricapillus	black-capped chickadee
P. rufescens	chestnut-backed chickadee
Psaltriparus minimus	bushtit
Certhia familiaris	brown creeper
Troglodytes troglodytes	winter wren
Thryomanes bewickii	Bewick's wren
Telmatocytes palustris	long-billed marsh wren
Turdus migratorius	robin
Catharus ustulatus	Swainson's thrush
Regulus satrapa	golden-crowned kinglet
R. calendula	ruby-crowned kinglet
Bombycilla cedrorum	cedar waxwing
Sturnus vulgaris	starling
Vireo gilvus	warbling vireo
Vermivora celata	orange-crowned warbler
V. ruficapilla	Nashville warbler

Appendix D continued.

Dendroica petechia	yellow warbler
D. coronata	yellow-rumped warbler
D. townsendi	Townsend's warbler
D. nigrescens	black-throated gray warbler
Geothlypis trichas	common yellowthroat
Wilsonia pusilla	Wilson's warbler
Agelaius phoeniceus	red-winged blackbird
Molothrus ater	brown-headed cowbird
Piranga ludoviciana	western tanager
Pheuctitus melanocephalus	black-headed grosbeak
Carpodacus purpureus	purple finch
C. mexicanus	house finch
Spinus tristis	American goldfinch
Passerculus sandwichensis	Savannah sparrow
Junco hyemalis	dark-eyed junco
Zonotrichia leucophrys	white-crowned sparrow
Z. atricapilla	golden-crowned sparrow

Mammals

Marsupialia	
Didelphis marsupialis	Opossum
Soricidae	
Sorex bendiri	Bendiri shrew
S. cinereus	masked shrew
S. vagrans	dusky or vagrant shrew
S. trowbridgii	trowbridge shrew
Talpidae	
Neurotichus gibbsi	shrew mole

Appendix D continued.

Leparidae	
Sylvilagus bachmani	brush rabbit
S. floridenus	eastern cottontail
Sciuridae	
Tamiasciurus douglasi	Douglas squirrel
Glaucomys sabrinus	northern flying squirrel
Castoridae	
Caster canadensis	beaver
Cricetidae	
Peromyscus maniculatus	deer mouse
Clethrionomys gapperi	boreal red-back vole
Microtus oregoni	Oregon vole
M. townsendi	Townsend's vole
Ondatra zibethica	muskrat
Muridae	
Rattus rattus	black rat
Zapodidae	
Zapus hudsonius	meadow jumping mouse
Z. trinotatus	northwest jumping mouse
Capromyidae	
Myocaster coypus	nutria
Canidae	
Canis latrans	coyote
Vulpes vulpes	red fox
Ursidae	
Ursus americanus	American black bear
Procyonidae	
Procyon lotor	raccoon
Mustelidae	
Mustela erminea	short-tailed weasel

Appendix D continued.

Mustela Prenata	long-tailed weasel
M. vison	mink
Mephitis mephitis	striped skunk
Lutra canadensis	river otter
Felidae	
Lynx rufus	bobcat
Cervidae	
Odocoileus hemionus	black-tailed deer

Appendix **E.** Conversion factors metric to english measure.

Meter = 3.3 feet

Kilometer = 0.6 miles (statue)

Hectare = 2.4 acres

English	Metric
5 feet	1.5 meters
10 feet	3.0
15 feet	4.6
1 mile	1.6 kilometers
2 miles	3.2
5 miles	8.0
10 miles	16.0
20 miles	32.2
1 acre	.4 hectare
5 acres	2.1 hectare
10 acres	4.2 hectare
20 acres	8.3 hectares
40 acres	16.7 hectares


FILMED
4-8